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Analysis of Economic Effects of Environmental Regulations on the Integrated Iron and Steel Industry. Volume I

Temple, Barker and Sloane, Inc., Wellesley Hills, Mass.

Prepared for

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ANALYSIS OF ECONOMIC EFFECTS OF ENVIRONMENTAL REGULATIONS ON THE

INTEGRATED IRON AND STEEL INDUSTRY

Volume I

Prepared for:

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PLANNING AND EVALUATION

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An analysis of the economic impact of environmental regulations on the Integrated Iron and Steel Industry. The most likely impact in terms of capital expenditures will be $6.8 billion for 1975 through 1983. Of this, $3.6 billion will be required for water and $3.2 billion will be required for air pollution control. Annual operating costs should increase less than 2 percent during the next decade. The increase to steel users will be less than 5 percent.

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PREFACE

This report is the result of a major program of studies sponsored by the Environmental Protection Agency as part of its continuing effort to assess the economic impacts of its regulatory programs. Unlike many of EPA's other industry economic studies where the focus is on the impact of a particular regulation, this study was aimed at examining the combined effect of all of EPA's direct regulatory programs on the integrated iron and steel industry. This was an ambitious objective and in some instances it was not possible to take every regulation into account due to the lack of data or the absence of final regulations; however, it was possible to focus quantitatively on the most significant programs, primarily those dealing with air and water pollution control.

In addition to providing an assessment of the combined impact of EPA's regulatory programs, a major objective of this study was to advance the methodologies used in previous studies so as to provide more accurate conclusions as well as provide a better foundation for future studies. This was done in many cases by making use of more up-to-date or previously unused data in areas such as industry production cost and pollution control cost. However, advances also may have been made in the basic analytical techniques used for impact analysis.

In sponsoring this study the EPA wanted to make an independent assessment of the integrated iron and steel industry. Although the overall conclusions are endorsed by the Agency, there may be instances in which technical judgments of the contractor differ from those of the EPA. Similarly, assumptions used in the study that are of a policy nature should not be construed as an indication of EPA policy intentions.

This report was prepared for EPA by Temple, Barker & Sloane, Inc. of Wellesley Hills, Massachusetts, under contract number 68-01-2832. Additional copies are available through the National Technical Information Service, Springfield, Virginia 22151. Further information concerning this and other economic studies conducted by EPA can be obtained through the Office of Planning and Evaluation, U.S. Environmental Protection Agency.

ACKNOWLEDGMENTS

A study of this complexity cannot be undertaken without the cooperation of many individuals. From the outset, Temple, Barker & Sloane, Inc. (TBS) worked closely with a committee of top level industry executives organized by Dr. S. Fletcher of the American Iron and Steel Institute (AISI). This AISI committee was chaired by Mr. W. Lowe of Inland Steel and included Messrs. F. Armour of Interlake, Inc., D. Brewster of Inland Steel, J. Lowey of Republic Steel, and E. Mallick and B. D. Smith of United States Steel (USS). TBS would like to express its appreciation for the contribution made by the members of this committee.

A number of other steel industry representatives also contributed to this study. Mr. B. D. Smith of USS and his staff, including Messrs. W. Renner, R. Ganem, L. Van der Veer and A. Skirboll, were particularly helpful. Throughout the TBS study, these USS representatives provided valuable industry perspective and insightful comments. We would like to offer our special thanks to Mr. R. Ganem. Messrs. D. Hawley of Inland Steel and A. Monnett of USS provided TBS with valuable assistance in the area of forecasting domestic steel shipments. In addition to Dr. Fletcher, other staff of the AISI making contributions include Messrs. F. Langenberg, J. Collins, E. Sommer, and K. Allen.

The TBS study utilized detailed industry operating data collected by Arthur D. Little for the AISI. Interpretation of these data was provided by Messrs. S. Margolin, K. Parmeswaran, T. Rothermel and J. Stevens.

Individuals from several organizations assisted in developing the detailed cost equations for pollution control equipment. Among these were Messrs. T. Centi and J. Boros of NUS/Cyrus Rice Division, P. Beltz and J. Varga of Battelle Columbus Laboratory, J. O'Connor and R. Jenkins of the Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards, and E. Hall, W. Hunt, E. Dulaney, J. Williams and P. Williams of the EPA's Effluent Guidelines Division.

EPA's Office of Planning and Evaluation provided direction throughout this project. Messrs. A. Brueckmann, S. Besse and J. Kamihachi guided TBS' effort, providing perspective, assisting in data collection, and undertaking more than their fair share of the unpleasant tasks associated with a project of this scope. Messrs. A. Alm, P. Brands and R. Gamse offered valuable comments and encouragement.

TBS' staff was augmented during the study by several key professionals from other organizations. Professor S. Bradley of the Harvard Business School assisted in the development of PTm(Steel), a computer-based model of the steel industry. Professor J. Light of the Harvard Business School developed TBS' analysis of capital market conditions in the past and the projections of future conditions. Mr. A. Steinburgh of Resource Planning Associates assisted in the initial stages of the project.

Valuable comments on an early draft of this report were received from: Messrs. B. D. Smith, D. Dilley and R. Ganem of USS; J. Briggs and R. Woodward of Bethlehem Steel; W. Sullivan of the Department of Commerce; R. Crandall and R. Greene of the Council on Wage and Price Stability; and D. Brazell of the Council of Economic Advisors.

While pleased to acknowledge all the assistance it has received during this study, TBS of course takes full responsibility for the study's analysis and conclusions.

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EXECUTIVE SUMMARY

This study provides a report of the economic impact of environmental regulations on the steel industry conducted by Temple, Barker & Sloane, Inc. (TBS) for the Office of Planning and Evaluation, Environmental Protection Agency (EPA). Its primary objective is to provide both public policy-makers and industry representatives with an independent, in-depth evaluation of the total economic impact of environmental regulations developed within the context of the uncertainties facing the steel industry during the next decade.

To our knowledge this study of the steel industry is unique in its approach--combining the cost impact methodology employed by Arthur D. Little in its study for the American Iron and Steel Institute (AISI) with, for the first time, a computer-based revenue requirement and external financing methodology which permits an integrated analysis of the economic impacts of environmental regulations.

As the foundation for this study, TBS has developed a Policy-Testing model of the steel industry, PTm(Steel). This computer-based model combines the planning assumptions of industry and technical experts with the structural relationships utilized by engineers and accountants.

REPORT COVERAGE

EPA chose as its definition of the steel industry those on-site facilities from raw materials storage yards for coke ovens and blast furnaces through finishing mills. As a result, facilities for mining, beneficiation, and transportation of raw materials to the site of coking and/or ironmaking as well as fabrication facilities are excluded, but facilities used by the steel industry to produce pig iron for foundries and other uses are included. In addition, all other non-steel operations by steel firms have been excluded from the impact analysis reported herein. It is estimated that steel operations as defined herein represented somewhat in excess of 70 percent of the net fixed assets of the major integrated steel companies during the 1972-1974 period.

In order to utilize detailed operating data compiled by AISI members, TBS limited its analysis to steel operations which produce approximately 93 percent of domestic steel shipments. While extrapolation to total steel operations could be made, extension of the analysis to iron ore and coal mining, beneficiation, transportation, fabrication and other non-steel operations by steel companies would be not advised.

Environmental requirements analyzed herein are limited to those promulgated, proposed and/or anticipated by EPA. They do not include government regulations initiated by other federal agencies, for example, Occupational Safety and Health Administration requirements. In addition, the engineering cost estimates and compliance schedules are based upon compliance by the steel firm at the plant site, not by municipal wastewater treatment facilities.

BASELINE CONDITIONS

In order to discuss the economic impact of environmental regulations on the steel industry, it is important first to create a point of reference from which comparisons can be made. In so doing, the uncertainties inherent in forecasting conditions within the steel industry which are unrelated to environmental regulations should be segmented from those associated with these regulations. This reference point requires the establishment of a baseline set of conditions which represents anticipated future operating conditions, excludes the impact of all pending environmental regulations, and includes the impact of pollution control equipment placed into service prior to 1975.

In establishing a baseline forecast for the steel industry, TBS has assumed that domestic steel shipments will rebound from the recession conditions evident in 1975 to the long-run trend by 1977 and continue to follow the long-run trend through 1983. This baseline forecast results in domestic steel shipments of 120 million tons by 1980.

The economic implications of this baseline can be summarized by focusing on five key indicators--capital expenditures, external financing needs, operations and maintenance expenses, revenue requirements, and average steel price per ton. These baseline conditions in the short and long run are as follows:

SUMMARY OF BASELINE CONDITIONS
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$8.7	$27.5
External Financing Needs	3.8	13.0
O&M Expenses	78.2	282.9
Revenue Requirements	96.1	338.6
Average Price (in 1975 dollars per ton)	$345.28	$365.21

Tables 1 and 2 provide a detailed summary of these economic indicators segmented into the short- and long-run impacts associated with the industry baseline conditions, water pollution control regulations, and air pollution control regulations. Table 3 contains O&M expenses for 1983, the first year during which all pollution control equipment is expected to be in operation.

ECONOMIC IMPACT OF WATER POLLUTION CONTROL

Based on the Phase I Development Document published in June 1974, the Phase II Development Document published in March 1976, and other water regulations anticipated but not covered by either Phase I or Phase II Effluent Guidelines, TBS estimates that capital expenditures for water pollution control equipment will total $3.6 billion during the 1975-1983 period, $2.5 billion of which will require external financing.[1] The capital-related charges associated with these expenditures, combined with the costs of operating the additions to water pollution control equipment, will total $5.8 billion. By 1983 these costs, if passed through in the form of higher prices, will increase the average steel price by $9.60 per ton--2.6 percent of the baseline price level.

A summary of the economic impact of water pollution control is as follows:

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[1] *It should be noted that although the statutory requirement is to meet Best Practicable Control Technology Currently Available requirements by July 1, 1977, this economic analysis is based upon an assumption that all existing steel facilities will achieve Best Practicable Control Technology Currently Available requirements on or before July 1, 1979, and Best Available Technology Economically Achievable requirements by July 1, 1983.*

WATER POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$1.8	$3.6
External Financing Needs	1.6	2.5
O&M Expenses	0.2	2.5
Revenue Requirements	0.7	5.8
Average Price Increase (in 1975 dollars per ton)	$3.42	$9.60

ECONOMIC IMPACT OF AIR POLLUTION CONTROL

Utilizing data from the 1974 Cost of Clean Air report for stack emissions and data supplied by EPA-Durham for fugitive emissions, TBS projects capital expenditures for air pollution control equipment to amount to $3.3 billion in the long run with related external financing needs of $2.1 billion.[2] The revenue requirements associated with these capital expenditures and operating expenses will approximate $5.7 billion and will require a 1983 price increase of $7.15 per ton. This price increase represents a 2.0 percent increase over the baseline price level.

A summary of the economic impact of air pollution control is as follows:

AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$2.1	$3.3
External Financing Needs	1.9	2.1
O&M Expenses	0.2	2.3
Revenue Requirements	0.9	5.7
Average Price Increase (in 1975 dollars per ton)	$3.82	$7.15

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[2] *This analysis is based upon installation of controls for stack emissions by July 1, 1978 and fugitive emissions by July 1, 1980.*

CAPITAL AVAILABILITY

During the last decade the steel industry has depended upon external sources for less than $1.0 billion. These external financing requirements represented only 5 percent of total applications. Between 1975 and 1983 the steel industry will require $17.5 billion in external financing. The $13.0 billion of external financing required for capacity expansion and modernization represents nearly 50 percent of total baseline applications. Environmental regulations will increase financing needs by $4.6 billion. These latter requirements represent 60 percent of the total application of funds associated with pollution control equipment.

The most serious financing problem, however, exists in the short run when environmental regulations will require $3.5 billion, a near doubling of the financing requirements for expansion and modernization. Nearly 90 percent of the funds used for pollution control equipment in the short run must be financed through external sources.

The industry's 1975-1977 capital market requirements may pose serious problems. First, these external financing requirements far exceed historical flows. Second, and more important, the industry's profitability in recent years has been such as to hamper its access to external financing. With the exception of 1974, when the relaxation of price controls and the worldwide shortage of steel and raw materials enabled the steel industry to raise its prices and operate at capacity, the industry's profitability has seriously lagged the all-manufacturing averages. As a consequence, financial analysts and investors in general have had a rather poor opinion of the industry in recent years. From 1970 through 1974, the ratio of the market value of the common stock of the six major integrated steel firms to the book value of their common stock was approximately 0.5.

Unless steel industry stock prices increase substantially, a major program of financing for capacity expansion or pollution control equipment installation would substantially dilute the book value of the shares of existing stockholders. If steel firms were unwilling to issue common stock at the depressed prices of recent years, a possible alternative would be to increase their debt-to-equity ratios above the historic levels of 30 to 40 percent. If the industry were to finance its expansion and pollution control equipment needs entirely with long-term debt issues, the debt-to-equity ratio would increase to 100 percent by 1983. Even if this mix of debt and equity were acceptable to investors (for example, in terms of interest coverage ratios), the cause for the shift and its magnitude would most likely have an adverse impact upon the current bond ratings of firms within the steel industry. Thus, under these conditions, a financing strategy calling for heavy debt financing would likely be viewed as highly undesirable, if possible at all.

The industry's basic financing problems could be exacerbated by tight capital market conditions and some observers have forecast a shortage of capital in the near future. As of late 1976, the probability of a credit crunch in the near term seems low, but TBS has considered the industry's financing requirements in the context of three possible scenarios concerning the total sources of capital and the uses of capital by other major segments of the U.S. economy. Under some assumptions, capital availability would be a problem for weak and interest-sensitive borrowers, such as individuals, state and local governments, and the weaker business firms. Firms having strong profit records and balance sheets are, however, unlikely to be squeezed by lack of access to external financing--though the cost of capital could be high in a scenario where investment needs are high and internally generated sources of funds are low.

The capital-availability analysis does not necessarily imply that the steel industry cannot finance its expansion and its pollution control requirements in the short run. While financing these requirements may be difficult, TBS believes that the task is manageable. To do so, however, the industry must be able to pass through the increased operating costs and capital-related charges associated with expansion and environmental requirements, including the rate of return on its common equity at least comparable to that realized on average by other manufacturing firms. Absent such a rate of return, some steel firms may curtail or defer capacity expansion plans either through choice or inability to raise the required external financing at an acceptable cost.

OTHER IMPACTS

The regulation and control of air and water pollutants in the steel industry will have other impacts. The most significant of these other effects will concern changes in the industry's consumption of energy and its levels of employment. Effects may also be expected in communities where significant amounts of steelmaking are concentrated and in the nation's balance of trade.

ENERGY

In relation to the large energy requirements for steel production, the energy impact of pollution control is small. Pollution control equipment placed into service during the 1975-1983 period will increase energy consumption by 0.4 quadrillion Btu, approximately 2 percent of the baseline levels. When the energy consumption of pollution control facilities already in place is included, total energy use associated with environmental regulations is calculated to be 0.8 quadrillion Btu, or less than 4 percent of the industry total. The energy requirements to operate all pollution control facilities within the steel industry will be 41,000 barrels of residual fuel oil or equivalent per day.

EMPLOYMENT

The construction, installation, and operation of pollution control facilities will create additional jobs. By 1983, compliance with all levels of pollution control guidelines will have created 12,500 additional jobs.

In addition to jobs created directly within the steel industry, the manufacture and installation of pollution control equipment are expected to generate an annual average of more than 15,000 jobs in pollution control equipment industries. This employment may, in turn, create additional employment in unrelated industries.

Some reduction in production labor may offset these employment increases. Jobs could be lost if the higher prices due to the cost of pollution control result in a decline in domestic steel shipments. Jobs could also be lost if specific mills or plants were shut down; however, shutting down one operation might require expanding production at another plant. The net effect of either of these conditions would be a decline in employment only to the extent that production is shifted from more labor-intensive operations to less labor-intensive ones or domestic production is replaced by imports and/or substitute materials.

COMMUNITY

The effect on communities of compliance with the proposed environmental regulations will vary by geographic region. Where plants are large and where significant amounts of steelmaking capacity are concentrated (e.g., in Pennsylvania with over 20 percent of U.S. steelmaking capacity), closing of processes at one plant may result in additional jobs at another plant nearby. Such community effects require specialized microeconomic analysis of plant-specific data.

EPA has conducted such an in-depth microeconomic analysis of the potential economic effects of pollution control costs on the eight steel plants in the Mahoning Valley region of eastern Ohio. Imposition of pollution controls or any other major increase in production costs is likely to reduce significantly the profitability of these plants. In these situations, the steel firms might elect to curtail operations rather than make the capital investment to meet environmental regulations.

BALANCE OF TRADE

In 1974 steel imports resulted in an unfavorable balance of trade of $3.0 billion, the greatest deficit of the decade. The pass-through of all pollution control costs, including a competitive return of common equity, implies a real price increase of 4.6 percent. Such an increase could affect adversely the ability of domestic producers to compete with imports. However, the bulk of steel costs are still represented by the baseline costs and, in this regard, most knowledgeable observers of the steel industry believe that the domestic steel industry is now cost competitive with foreign steel producers. Future capacity expansion and the shift to more efficient steel-making should increase this comparative advantage.

It is not possible to foresee accurately the final effect of pollution control regulations when superimposed on other events possibly even more important insofar as our balance of trade is concerned. Net imports of steel is the most difficult measure to forecast since it is affected directly not only by domestic economic developments but by foreign ones as well. In addition, foreign steel has been an instrument of government policy in the past.

STEEL CONSUMERS

Steel purchasers are not normally end users of the product, but convert it to products. The magnitude of steel price increase attributable to pollution control regulations is probably not significant enough to lead to major substitutions of other materials. Thus steel purchasers can be expected to pass any steel price increases on to steel consumers in the form of increased product prices. The resulting product price increase would be a much smaller percentage than the percentage for steel. For example, the cost of a new auto is expected to increase $19.28 to reflect the increased cost of steel due to pollution control regulations.

GUIDE TO THE REPORT

This report consists of two volumes. Volume I presents findings and conclusions. Volume II describes the methodology employed in the analysis.

Volume I includes nine sections and seven appendices. In general, the sections provide an overview of results and summary data. Where appropriate, additional data have been provided in appendices. A brief description of each section and appendix in Volume I appears below.

- Section 1 surveys the report coverage and research methodology;
- Section 2 details the industry baseline projections;
- Section 3 estimates the cost impacts of water pollution control equipment;
- Section 4 projects the cost impacts of air pollution control equipment;
- Section 5 summarizes the cost impacts of environmental regulations and relates them to the industry baseline;
- Section 6 analyzes the revenue requirements and price effects associated with these cost impacts;
- Section 7 delineates the external financing needs which follow from these cost impacts;

- Section 8 describes other effects of these environmental regulations; and

- Section 9 generally describes the methodology employed in preparing this report.

- Appendix A provides an historical perspective on the steel industry;

- Appendix B adds detailed findings to the industry baseline in Section 2;

- Appendix C adds detailed findings to the cost estimates for water pollution control equipment in Section 3;

- Appendix D adds detailed findings to the cost projections for air pollution control equipment in Section 4;

- Appendix E adds detailed findings on revenue requirements and price effects in Section 6;

- Appendix F adds detailed findings regarding external financing needs summarized in Section 7; and

- Appendix G adds detailed findings describing other effects of these environmental regulations as summarized in Section 8.

Volume II includes five sections and two appendices. Each section describes in detail the methodology and data used for a part of the analysis. The appendices provide more extensive and technical explanation of the model structure. A brief description of each section and appendix in Volume II appears below.

- Section 1 is an introduction to the methodology;

- Section 2 describes the method and data used to determine all costs of production;

- Section 3 describes the method and data used to determine all costs incurred in meeting water pollution control requirements;

- Section 4 describes the method and data used to determine all costs incurred in meeting air pollution control requirements; and

- Section 5 explains the method and data used to place the costs determined in Sections 1, 2, and 3 into a framework of financial results of operations.

- Appendix A describes the method used to develop the steel shipments forecast and the alternatives considered;

- Appendix B details calculations used to determine depreciation and reinvestment.

Table 1

SHORT-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS

1975-1977

(billions of 1975 dollars unless otherwise specified)

	Capital Expenditures		External Financing		Operations & Maintenance		Revenue Requirements		Average 1977 Price	
	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount (dollars)	Percent of Baseline (%)
Industry Baseline Conditions										
Iron and Steel Production	$8.72	100.0	$3.74	99.2	$77.27	98.8	$94.87	98.7	$341.17	98.8
Water PCE***In Place	-	-	0.04	1.1	0.68	0.9	0.93	1.0	3.12	0.9
Air PCE*** In Place	-	-	(0.01)	(0.3)	0.22	0.3	0.32	0.3	0.99	0.3
Total Baseline Conditions	$8.72	100.0	$3.77	100.0	$78.17	100.0	$96.11	100.0	$345.28	100.0
Water PCE Additions										
Phase I Processes	$0.25	2.9	$0.24	6.4	$0.03	*	$0.11	0.1	$0.56	0.2
Phase II Processes	1.33	15.3	1.18	31.3	0.13	0.2	0.53	0.6	2.46	0.7
Storm Runoff Guideline	0.02	0.2	0.02	0.5	-	-	**	-	0.02	*
Other Water PCE***	0.16	1.8	0.15	4.0	0.03	*	0.07	0.1	0.38	0.1
Total Water PCE*** Additions	$1.76	20.2	$1.59	42.2	$0.19	0.2	$0.73	0.8	$3.42	1.0
Air PCE Additions										
Stack Emissions	$1.33	15.3	$1.16	30.8	$0.19	0.2	$0.69	0.7	$2.98	0.9
Fugitives Emissions	0.63	7.2	0.62	16.4	-	-	0.10	0.1	0.54	0.2
Other Air PCE***	0.13	1.5	0.12	3.2	0.02	*	0.07	0.1	0.30	0.1
Total Air PCE*** Additions	$2.09	24.0	$1.90	50.4	$0.21	0.3	$0.86	0.9	$3.82	1.2
Grand Total	$12.56	144.0	$7.26	92.6	$7 .56	100.5	$97.69	101.6	$352.52	102.1

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*Less than 0.05 percent

**Less than $5 million

***Pollution control equipment

Table 2

LONG-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS
1975-1983
(billions of 1975 dollars unless otherwise specified)

	Capital Expenditures		External Financing		Operations & Maintenance		Revenue Requirements		Average 1983 Price	
	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount (dollars)	Percent of Baseline (%)
Industry Baseline Conditions										
Iron and Steel Production	$27.50	100.0	$13.23	101.8	$279.91	99.0	$334.95	98.9	$361.96	99.1
Water PCE** In Place	-	-	(0.15)	(1.2)	2.29	0.8	2.80	0.9	2.57	0.7
Air PCE** In Place	-	-	(0.09)	(0.7)	0.67	0.2	0.85	0.3	0.68	0.2
Total Baseline Conditions	$27.50	100.0	$12.99	100.0	$282.87	100.0	$338.61	100.0	$365.21	100.0
Water PCE Additions										
Phase I Processes	$0.65	2.4	$0.48	3.7	$0.45	0.2	$0.98	0.3	$1.76	0.5
Phase II Processes	2.18	7.9	1.39	10.7	1.14	0.4	3.25	1.0	4.22	1.2
Storm Runoff Guideline	0.15	0.5	0.12	0.9	0.10	*	0.20	0.1	0.53	0.1
Other Water PCE**	0.60	2.2	0.49	3.8	0.85	0.3	1.32	0.4	3.09	0.8
Total Water PCE** Additions	$3.57	13.0	$2.49	19.2	$2.54	0.9	$5.75	1.7	$9.60	2.6
Air PCE Additions										
Stack Emissions	$1.65	6.0	$0.93	7.2	$0.96	0.3	$2.78	0.8	$2.70	0.7
Fugitives Emissions	1.34	4.9	0.95	7.3	1.15	0.4	2.44	0.7	3.70	1.0
Other Air PCE**	0.26	0.9	0.18	1.4	0.22	0.1	0.47	0.1	0.75	0.2
Total Air PCE** Additions	$3.25	11.8	$2.06	15.9	$2.34	0.8	$5.68	1.7	$7.15	2.0
Grand Total	$34.32	124.8	$17.54	135.0	$287.74	101.7	$350.04	103.4	$381.96	104.6

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*Less than 0.05 percent
**Pollution control equipment

Table 3

OPERATIONS & MAINTENANCE EXPENSES OF ENVIRONMENTAL REGULATIONS

1983

(billions of 1975 dollars)

	Amount	Percent of Baseline (%)
Industry Baseline Conditions		
Iron and Steel Production	$36.43	99.0
Water PCE In Place	0.28	0.8
Air PCE In Place	0.07	0.2
Total Baseline Conditions	$36.78	100.0
Water PCE Additions		
Phase I and II Processes	$ 0.32	0.9
Storm Runoff Guideline	0.04	0.1
Other Water PCE	0.26	0.7
Total Water PCE Additions	$ 0.62	1.7
Air PCE Additions		
Stack and Fugitive Emissions	$ 0.37	1.0
Other Air PCE	0.05	0.1
Total Air PCE Additions	$ 0.42	1.1
Grand Total	$37.82	102.8

1. INTRODUCTION

This report culminates a twenty-four-month effort by Temple, Barker & Sloane, Inc. (TBS) to evaluate the economic impact of environmental regulations on the steel industry for the Office of Planning and Evaluation, Environmental Protection Agency (EPA). Its objective is to provide both public policy-makers and industry representatives with an independent, in-depth evaluation of the total economic impact of environmental regulations within the context of the uncertainties facing the steel industry during the next decade. Appendix A provides a perspective on the steel industry prior to this study.

The economic and regulatory climate in which the steel industry operates has undergone drastic changes since this study was initiated. Record profits within the steel industry were achieved in 1974 and the industry was looking forward with optimism. The economic recession from which the United States now appears to have largely recovered was devastating in its effect upon the steel industry. Shipments declined by more than 25 percent during 1975, but by year-end the industry was once again looking forward with optimism--tempered by the economic realities of an uncertain economy, foreign competition, and continued government regulation.

The relaxation of steel price controls during 1974 was a major factor in the industry's record performance that year. Perhaps just as important was the anticipation of shortages in basic raw materials which led to a significant increase in steel product inventories held by steel customers.

The year 1975 was marked by direct confrontation between the Council on Wage and Price Stability (CWPS) and the steel industry over price increases. The CWPS Steel Symposium was convened in December 1975 to discuss in public forum the major differences of opinion evident among public policy-makers, industry spokesmen, knowledgeable industry observers, and representatives of major steel consumers.

It is hoped that this report will further assist in promoting open discussion of public policy as it impacts the steel industry and will extend this dialogue to include the economic impact of environmental regulations.

REPORT COVERAGE

In analyzing the steel industry, EPA necessarily had to define the boundaries of its analysis. In so doing, EPA chose as its definition of the steel industry those on-site facilities from raw materials storage yards for coke oven and blast furnaces through finishing mills.[1] As a result, facilities for mining, beneficiation, and transportation of raw materials to the site of coking and/or ironmaking as well as fabrication facilities are excluded, but facilities used by the steel industry to produce pig iron for foundries and other uses are included. In addition, all other non-steel operations by steel firms have been excluded from the impact analysis reported herein.

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[1] *Utilizing data provided by AISI, it is estimated that steel operations as defined herein represented somewhat in excess of 70 percent of the net fixed assets of the major integrated steel companies during the 1972-1974 period. If iron ore, metallurgical coal, and scrap metal were transferred at market values, sales revenues from steel operations approximated 80 percent of the total revenues of these firms during this period.*

The American Iron and Steel Institute (AISI), whose members operate 139 steel plants, provided detailed operating data on 130 of these plants for its cost impact study conducted by Arthur D. Little (ADL).[2] These plants account for approximately 93 percent of domestic steel shipments and, in order to utilize the ADL data, TBS limited its analysis to these same facilities. While extrapolation to total steel operations could be made, extension of the analysis to iron ore and coal mining, beneficiation, transportation, fabrication, and other non-steel operations by steel companies would not be advised.

RESEARCH METHODOLOGY

To our knowledge this study of the steel industry is unique in its approach--utilizing the cost impact methodology employed by ADL in its study for the AISI and developing, for the first time, a computer-based revenue requirement and external financing methodology which permits an integrated analysis of the economic impacts of environmental regulations within the context of uncertain operating conditions.[3]

As the foundation for this study, TBS has developed a Policy-Testing model of the steel industry, hereinafter referred to as PTm(Steel). This computer-based model combines the planning assumptions of industry and technical experts with the structural relationships utilized by engineers and accountants. Underlying PTm(Steel) are three independent modules which correspond to (1) production facilities planning and operations, (2) pollution control equipment planning and operations, and (3) revenue requirements and external financing needs determination. The first two modules provide the cost impacts which, when combined with the revenue requirements module, permit an integrated statement of the economic impact of environmental regulations.

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[2] *Steel and the Environment: A Cost Impact Analysis,* Arthur D. Little for the American Iron and Steel Institute, May 1975.

[3] *In its report ADL concluded, "Several attempts have already been made to examine the economic impact of pollution control costs on the iron and steel industry. These have been severely limited by the lack of the kind of data ~~now~~ provided by this (i.e., ADL) study. An economic impact analysis, the next step after this cost impact examination, is needed to evaluate the full implications of pollution control costs for the iron and steel industry." (Ibid, p. VI-60)*

All financial transactions within PTm(Steel) are computed in current dollars.[4] During periods of inflation, these financial transactions recognize cost escalation where relevant (e.g., operations and maintenance expenses) as well as a historic cost basis (e.g., depreciation). However, for purposes of comparability, all financial data have been reported in constant 1975 dollars. In so doing, transactions have been inflated at sectoral rates of inflation and deflated by the rate of overall inflation (i.e., GNP deflator).[5]

The economic impact analysis reported herein focuses upon the 1975-1983 time period. In order to capture the cumulative effect of environmental regulations during this period, most exhibits provide detailed information for the three-year periods 1975-1977, 1978-1980 and 1981-1983 as well as the

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[4] *Current dollar costs are the amounts one expects to actually pay for goods or services in a year. Constant dollars are those current dollar amounts adjusted for inflation to their value in a stated year.*

[5] *For example, assume that a rolling mill completed in 1975 costs $100.0 million. A comparable facility scheduled for initial operation in 1980 would cost $161.1 million in current dollars and $126.2 million in constant 1975 dollars if the sectoral rate of inflation in the construction industry were 10 percent and overall GNP inflation were 5 percent during the 1976-1980 period.*

1975-1983 period. The text and the tables therein summarize these data into short-run (1975-1977) and long-run (1975-1983) time periods.

In comparing the ADL methodology with PTm(Steel), it should be noted that the ADL computer-based model is capable of computing the cost impacts on a process, plant, and/or company basis. The methodology utilized by TBS is consistent with these levels of analysis; however, the data provided TBS by ADL with the concurrence of AISI do not permit analyses at either the plant or company level. The AISI data were aggregated prior to their dissemination to TBS and others in order to avoid divulging proprietary operating data. When more detailed data become available, analyses at the plant and/or company level can be undertaken. However, these data were not required to perform the economic impact analysis herein reported.

2. INDUSTRY BASELINE CONDITIONS

In order to discuss the economic impact of environmental regulations on the steel industry, it is important first to establish a point of reference from which comparisons can be made. In so doing, the uncertainties inherent in forecasting conditions within the steel industry which are unrelated to environmental regulations should be segmented from those associated with these regulations. This reference point requires the establishment of a baseline set of conditions which represents anticipated future operating conditions, which excludes the impact of all pending environmental regulations--promulgated, proposed, and anticipated,[1] but which includes the impact of pollution control equipment placed into service prior to 1975.

The major steps undertaken to establish this industry baseline include:

- specifying future domestic steel shipments,
- determining capacity expansion requirements,
- projecting capital expenditures for capacity expansion and modernization,
- determining the level of capital expenditures for pollution control equipment placed into service prior to 1975,

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[1] *Environmental requirements analyzed herein are limited to those promulgated, proposed and anticipated by EPA. Thus they do not include regulations initiated by other federal agencies; for example, OSHA requirements. In addition, the engineering cost estimates and compliance schedules are based upon compliance by the steel firm at the plant site, and excludes costs borne by municipal waste-water treatment facilities.*

- estimating operations and maintenance expenses associated with the above-mentioned production requirements and operation of pollution control equipment,

- projecting the revenues required to cover operating expenses and capital-related charges, and

- determining external financial needs.

The remainder of this section will describe the first five steps in this process of specifying an industry baseline. The last two steps will be discussed in Sections 6 and 7 following the computation of all the cost impacts, including those associated with environmental regulations. Additional detail on the first five steps is contained in Appendix B.

STEEL SHIPMENTS

Perhaps the most uncertain element in this baseline set of conditions is forecasting the future level of domestic steel shipments. Following a steady rate of growth during the early 1960s, domestic steel shipments remained relatively stagnant near 90 million tons from 1965 through 1972 as steel imports increased 70 percent. Record levels for domestic shipments, averaging 110 million tons per year, occurred in 1973 and 1974. Preliminary estimates of shipments during 1975 indicate a decline of approximately 25 percent from the 1974 level.

In establishing a baseline forecast for the steel industry, TBS has assumed that domestic steel shipments will rebound from the recession conditions evident in 1975 to the long-run trend by 1977 and continue to follow the long-run trend through 1983. This forecast, summarized in Exhibit 1, projects an annual growth in total domestic shipments of 2.53 million tons per year from 1977 onward and results in total domestic steel shipments of 113.0 million tons in 1977, 120.6 million tons in 1980, and 128.2 million tons in 1983.[2]

Recognizing that the capital expenditures for capacity expansion and modernization associated with any prespecified level for future domestic steel shipments would be highly problematic, TBS also specified both an optimistic and pessimistic level of shipments which deviated in the long run from baseline levels by plus and minus 10 percent, respectively. In selecting these alternative rates for growth in steel shipments, it should be noted that recent forecasts of 1980 shipments by AISI, the International Iron and Steel Institute, Arthur D. Little (for the AISI), Booz, Allen & Hamilton (in separate studies for the Council on Environmental Quality and the Department of Commerce), Chase Econometrics, Data Resources, Inc., and the Bureau of Labor Statistics differ from the baseline forecast by less than 7 percent.

CAPACITY EXPANSION

The forecast baseline growth in steel shipments implies a need for capacity expansion. In analyzing this need, TBS assumed that the steel industry will expand its capacity to meet anticipated steel shipment requirements and to be able to operate at planned levels of utilization.[3] During the 1973-1974 period, many steelmaking and finishing processes operated at levels above their sustainable utilization. If shipments return to the long-run trend by 1977, a substantial amount of the steelmaking, continuous casting, and finishing expansion will be needed in the short run.

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[2] *The analysis reported herein is limited to steelmaking and finishing facilities which represent 93 percent of domestic shipments. Thus the corresponding baseline forecast of shipments would be 105.1 million tons in 1977, 112.2 million tons in 1980 and 119.2 million tons in 1983.*

Capacity additions through 1983 to basic oxygen and electric furnaces of approximately 50 million tons will be required to meet the baseline shipments forecast and to replace open hearth capacity being retired. These additions imply a net increase in steelmaking capacity of approximately 25 million tons, necessitating the expansion of coal, scrap, and coking facilities, and the replacement of approximately 10 million tons of ironmaking capacity in the form of old blast furnaces which are currently not in blast. The transition toward continuous casting will require the addition of continuous casting facilities capable of producing nearly 30 million tons. Most finishing mills--especially wire, pipe and tubing, galvanizing and tin plating, and plate--will require additional capacity to meet the baseline requirements.

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[3] *It should be noted that this approach assumes that the industry, as well as each firm within the industry, will add facilities to achieve balances in terms of annual throughput. Given the importance of maintaining market share and the economies of scale evident in several processes, this approach projects the minimum capital expenditures required to meet a specified projection of domestic steel shipments.*

CAPITAL EXPENDITURES FOR EXPANSION AND MODERNIZATION

The capital expenditures implied by the above-mentioned schedule of capacity additions are as follows:

CAPITAL EXPENDITURES FOR EXPANSION AND MODERNIZATION
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capacity Expansion		
Placed Into Service	$3.33	$ 9.61
Changes in Construction Work in Progress	0.40	2.01
TOTAL	$3.73	$11.62
Capacity Modernization	4.99	15.89
GRAND TOTAL	$8.72	$27.50

These capital expenditures for capacity expansion and modernization are detailed by stage of production and by time period in Exhibits 2 and 3, respectively.[4]

Expenditures for the expansion of production capacity amount to $3.7 billion in the short run and $11.6 billion in the long run--approximately $1.3 billion per year, and include both equipment placed into service during the period and changes in the amount under construction. In the long run these expenditures for increases in construction work in progress (CWIP) exceed $2.0 billion, an amount ignored in most studies of the steel industry.[5]

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[4] *TBS has segmented steel production into 28 processes. These processes are then organized into five stages of production--on-site raw materials preparation, ironmaking, steelmaking, casting and forming, and finishing. Exhibit 4 provides a schematic diagram of the steel production process.*

The TBS approach to estimating capital expenditures for capacity expansion, which focuses on production requirements and capacity additions by process, differs significantly from the methods employed by other industry observers. Other estimates of expansion requirements focus on overall steelmaking facilities which, when combined with a rough estimate of the cost of adding a ton of raw steel capacity (ranging from $200 to more than $800 per ton), permits an estimate of capital expenditures for expansion. Furthermore, estimates of additions to steelmaking capacity are often confounded by an unspecified conversion from open hearth to basic oxygen and electric furnace production.

In addition to capital expenditures for capacity expansion, outlays for modernization of existing capacity represent a relatively constant flow of funds which usually cannot be delayed or curtailed without operating inefficiencies and/or loss of productive capacity. These expenditures for reworking and/or replacing existing facilities do not result in increased capacity. They amount to $5.0 billion in the short run and $15.9 billion in the long run and comprise 57 percent of baseline capital expenditures.

AISI estimates expenditures for capacity modernization by focusing upon the aggregate level of capital expenditures during the past decade when productive capacity remained relatively unchanged.[6] The TBS methodology permits more detailed analysis than the approaches used by AISI and other industry observers. Utilizing AISI data provided by ADL, TBS estimated annual capital expenditures required to maintain a ton of existing capacity for each process.[7] These annual expenditures, prior to adjustment for cost escalation. ranged from 1.0 to 6.8 percent of the original construction cost.

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[5] *Consideration of the timing of required funds flows requires accounting for changes in CWIP as well as the amount of equipment placed in service since CWIP indicates the amount expended for facilities not completed during the period.*

[6] *Steel Industry Economics and Federal Income Tax Policy, American Iron and Steel Institute, June 1975.*

The TBS methodology for computing capital expenditures for modernization yields estimates comparable to those developed by other observers. For example, AISI has reported that total capital expenditures by the steel industry during the last decade have averaged $1.8 billion per year. The TBS estimate of capital expenditures for the modernization of steel operations during the 1975-1983 period is $1.8 billion per year.[8]

CAPITAL EXPENDITURES FOR POLLUTION CONTROL EQUIPMENT IN SERVICE

In specifying industry baseline conditions, TBS included the impact of pollution control equipment which was placed into service prior to 1975. The impact of in-place pollution control equipment includes past capital expenditures which must be recovered as well as the annual operations and maintenance expenses which are incurred. These past capital expenditures will result in depreciation and other capital charges during the next decade.

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[7] *This method of computing capital expenditures for modernization and reworks was suggested, although not employed, by ADL in its study for AISI. Instead, ADL utilized the AISI approach to estimate these expenditures.*

[8] *It should be noted that the TBS estimate is in constant 1975 dollars and covers only 93 percent of the steel industry. The AISI concludes, "...it is estimated that capital expenditures to maintain present capacity during the 1975-1983 period will approximate at least $2.0 billion per year before escalation." (op. cit., p.24). Thus, TBS expenditures for reworks and modernization approximate those proposed by the AISI.*

As a basis for determining the impact of these environmental facilities, EPA technical contractors estimated by process the proportion of existing facilities which have installed equipment necessary for compliance with each of the water effluent guidelines and air emission standards. Utilizing these proportions, TBS estimated capital expenditures incurred prior to 1975 for pollution control facilities to be nearly $2.2 billion--$1.5 billion for water and $0.7 billion for air pollution control equipment.

OPERATIONS AND MAINTENANCE EXPENSES[9]

PTm(Steel) computes production requirements for each process which are consistent with the previously cited baseline forecast of steel shipments. When these production requirements are combined with factor prices for each resource employed, operations and maintenance (O&M) expenses during the 1975-1983 period are as follows:

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[9] *Operations and maintenance expenses for iron and steel production as defined herein include direct labor and overhead, raw materials, energy, supplies and other utilities, but exclude depreciation and other capital charges.*

OPERATIONS AND MAINTENANCE EXPENSES FOR IRON AND STEEL PRODUCTION

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Basic Raw Materials	$37.29	$140.65
Direct Labor and Overhead	28.44	99.93
Other O&M Costs	11.54	39.33
TOTAL	$77.27	$279.91

These O&M expenses for iron and steel production are detailed by stage of production and by time period in Exhibit 5.

Operations and maintenance expenses represent the largest component of steel industry costs. These expenses, which are expected to average $25.8 billion per year in the short run and $31.1 billion per year in the long run, are dominated by basic raw material costs and labor-related charges. The remainder of O&M expenses can be accounted for by other raw materials (e.g., fluxes and alloying elements), energy in the form of natural gas, fuel oil and electricity, and miscellaneous maintenance supplies and utilities.

Basic raw materials represent the largest and fastest growing component of O&M expenses--38 percent of O&M expenses in 1972, 48 percent in the short run and 50 percent in the long run. In projecting iron ore and metallurgical coal prices, TBS has assumed that the recent decline in productivity within underground coal mines will continue during the next decade and that future wage increases of miners will parallel those of steelworkers. Furthermore, it is anticipated that the cost per ton of scrap metal charges to steelmaking furnaces will be comparable to the cost of hot metal charges.[10]

Direct labor and related overhead charges are assumed to escalate at a rate in excess of inflation within the economy in general. However, the significant increase in raw material prices results in a relative decline in labor's share of O&M expenses from 43 percent in 1972 to 37 percent in the short run and 36 percent in the long run.

In addition to these O&M expenses for iron and steel production, operation of pollution control equipment placed into service prior to 1975 will require expenses totalling $3.0 billion during the 1975-1983 period as follows:

OPERATIONS AND MAINTENANCE EXPENSES FOR POLLUTION CONTROL EQUIPMENT PLACED INTO SERVICE PRIOR TO 1975

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Water Pollution	$0.68	$2.29
Air Pollution	0.22	0.67
TOTAL	$0.89	$2.96

Exhibits 6 and 7 detail these O&M expenses by stage of production and by time period for water and air pollution control equipment, respectively.

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[10] *These assumptions imply basic raw material costs (in nominal terms) of $27.32, $46.35, and $100.72 per ton in 1977 and $38.86, $84.60, and $158.67 per ton in 1983 for iron ore, metallurgical coal, and scrap metal, respectively.*

These operating expenses are estimated to be $0.3 billion per year in the short run and approximately 10 percent higher in the long run. More than 75 percent of the O&M expenses associated with pollution control equipment placed into service prior to 1975 will be required to operate water pollution control equipment, with the remainder associated with air pollution control.

Throughout subsequent analyses of environmental regulations, these impacts from existing equipment will be separated from those associated with pollution control equipment additions required to meet environmental regulations promulgated, proposed, and anticipated.

3. COST IMPACT OF FEDERAL WATER POLLUTION CONTROL ACT AND OTHER WATER POLLUTION REGULATIONS

The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500, hereinafter referenced as the Water Act) constitute the statutory basis of regulatory responsibility in the area of effluent standards. The national objective declared by this environmental legislation is to eliminate by 1985 discharges of pollutants into navigable waters. As an interim goal, waters are to be suitable by July 1, 1983, for both the purposes of human recreation and the growth of fish, shellfish, and other wildlife. The Water Act stipulates the goal of improving receiving water quality by cleaning up industrial process discharges with means which are both technologically and economically feasible.

The Water Act charged EPA with the responsibility of developing limitations guidelines for point sources of effluents. In addition, authority for discharge permit programs was transferred from the U.S. Army Corps of Engineers, with whom it had traditionally rested, to the EPA.

Section 301(b) of the Water Act specifies limitation standards based on the application of Best Practicable Control Technology Currently Available (BPCTCA) which are to be operational in all existing steel industry facilities by July 1, 1977. The industry is expected to meet a higher standard of water effluent control in existing facilities by July 1, 1983 based on the application of Best Available Technology Economically Achievable (BATEA) which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants.

The Water Act further requires EPA to establish a set of effluent standards known as New Source Performance Standards (NSPS) to regulate new facilities on which construction is begun after the publication of the proposed NSPS effluent guidelines. Performance standards at such new sources are to reflect the greatest degree of effluent reduction achievable through the application of the Best Available Demonstrated Control Technology (BADCT) which, where practicable, affords a standard permitting no discharge of pollutants.

Given the statutory requirements laid out in the Water Act, EPA contracted with the Cyrus Rice Division of NUS Corporation (NUS/Rice) to conduct an extensive engineering study of the steel industry to develop effluent limitations guidelines. For purposes of that analysis, the operations of the industry were divided into two parts: raw steelmaking processes and hot forming/cold finishing processes (Phases I and II respectively).

The first segment of the NUS/Rice study, which covered steelmaking operations from raw material preparation through continuous casting of steel, is referred to as the Phase I document.[1] The standards were published in the June 28, 1974 Federal Register.

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[1] *EPA-440/1-74-024-a, Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steelmaking Segment of the Iron and Steel Manufacturing Point Source Category, June 1974.*

Subsequently, the Phase I guidelines came under judicial review in court cases instituted by the AISI and several steel companies. The resulting decision handed down in November 1975 by the U.S. Court of Appeals, Third Circuit, remanded the guidelines for review of certain sections by EPA. That review is under way.

The final Phase II guidelines were published in the March 29, 1976 Federal Register.[2] Phase II processes include breaking of ingots into primary forms and subsequent processes through finishing and coating. An earlier draft of these Phase II guidelines was released by EPA. This draft, the Advanced Notice of Proposed Rulemaking, was published in the August 21, 1975 Federal Register, but did not have the legal standing of proposed standards.[3]

The statutory date for achievement of BPCTCA is July 1, 1977. In many cases within the iron and steel industry this compliance date may not be achieved due to construction lead times which depend upon the specific situation at individual plants. The following analysis of the economic impact of the Water Act has been based upon an assumption that that full compliance with BPCTCA requirements will occur sometime during the period between July 1, 1979 and July 1, 1981.

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[2] *EPA-440/1-76/048-b, Development Document for Interim Final and Proposed Effluent Limitations Guidelines and New Source Performance Standards for Forming, Finishing and Specialty Steel Segments of the Iron and Steel Manufacturing Point Source Category, March 1976.*

[3] *EPA-440/1-75/048, Development Document for Advanced Notice of Proposed Rulemaking for Effluent Limitations Guidelines and New Source Performance Standards for the Hot Forming and Coal Finishing Segment of the Iron and Steel Manufacturing Point Source Category, March 1976.*

This report highlights the impacts of compliance by July 1, 1979. The implications of compliance by July 1, 1981 are presented at the end of this section. Additional detail on costs presented in this section is presented in Appendix C.

COSTING METHODOLOGY

In projecting the cost impacts of the Water Act and other water pollution regulations, detailed engineering cost estimates developed for EPA by NUS/Rice on the basis of a model plant size were converted into capital cost and operating cost equations which recognize scale economies in the construction and operation of water pollution control equipment. In so doing, TBS translated the NUS/Rice engineering cost estimates to a basis directly comparable with similar estimates developed by ADL in its cost impact study for AISI.

The NUS/Rice engineering cost estimates, when combined with the AISI inventory of steel facilities by process and a schedule for compliance with BPCTCA, BATEA, NSPS, and other guidelines, permit a detailed analysis of the cost impacts associated with the Water Act. These cost impacts are then analyzed within the context of the previously cited industry baseline conditions to determine the economic impacts of environmental regulations.

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT

Capital expenditures for water pollution control equipment expected to be placed into service during the 1975-1983 period to meet the requirements of the Water Act and other water regulations are estimated as follows:

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Phase I Processes	$0.26	$0.65
Phase II Processes	1.32	2.18
TOTAL	$1.58	$2.83
Storm Runoff	0.02	0.15
Other Water	0.16	0.60
GRAND TOTAL	$1.76	$3.57

These capital expenditures are detailed by stage of production and by time period or by effluent guideline in Exhibits 8 and 9, respectively.

Of the $3.6 billion in capital expenditures for water pollution control equipment required in the long-run period (1975-1983), nearly one-half will be expended during the short-run period (1975-1977). By far the largest component of these capital outlays is required to meet the anticipated Phase II effluent guideline which represents 75 percent of the short-run and 60 percent of the long-run requirements.

The long-run relationship between capital expenditures for process equipment to meet effluent guidelines and expenditures for capacity additions can be approximated by comparing NSPS costs to outlays for capacity expansion during the same time period. Using the mix of capacity additions during the 1981-1983 period, this long-run impact is estimated to be less than 4 percent.

Since capital expenditures herein defined include increases in construction work in progress, short-run requirements include cash payments for pollution control equipment to be placed into service after 1977. In fact, exactly one-half of the short-run capital expenditures represent outlays for construction work in progress. In the long run, expenditures for increases in construction work in progress comprise 10 percent of total outlays during the 1975-1983 period.

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

Operations and maintenance expenses associated with operating water pollution control equipment placed into service during the 1975-1983 period are projected as follows:

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Phase I Processes	$0.03	$0.45
Phase II Processes	0.13	1.14
TOTAL	$0.16	$1.59
Storm Runoff	--	$0.10
Other Water	0.03	0.85
GRAND TOTAL	$0.19	$2.54

Total O&M expenses are detailed by stage of production and by time period or by effluent guideline in Exhibits 10 and 11, respectively. It should be noted that these exhibits include O&M expenses associated with water pollution control equipment placed into service prior to 1975. On the other hand, the preceeding table represents only the difference between total O&M expenses and those expenses for equipment already placed into service. O&M expenses for water pollution control equipment placed into service prior to 1975 were detailed in Exhibit 6.

The operations and maintenance expenses associated with water pollution control facilities expected to be installed within the 1975-1977 period amount to less than $0.2 billion in the short run. These short-run O&M expenses are overshadowed by the $0.7 billion required to operate the equipment placed into service prior to 1975. In the long run, the additions to water pollution control equipment represent $2.5 billion, more than 50 percent of the $4.8 billion required to operate all water pollution control equipment.[4] By 1983, water pollution control equipment placed into service during the 1975-1983 period will increase annual O&M expenses by more than $0.6 billion.

By far the largest component of these additional operating expenses is that linked to the operation of water pollution control equipment on steel finishing mills. These O&M expenses exceed $1.0 billion during the 1975-1983 period and represent 65 percent of the operating costs for process-related equipment. Another major component is associated with other water regulations, including equipment required to control thermal, non-contact cooling, utility area, and wastewater discharges not covered by either Phase I or Phase II effluent guidelines.

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[4] *It should be noted that O&M expenses comprise cumulative expenditures during the period. Since the amount of pollution control equipment installed increases in each year, no simple average will determine the impact of pollution control in relation to production expenses.*

COMPARISON OF ALTERNATIVE ENGINEERING COST ESTIMATES FOR WATER POLLUTION CONTROL EQUIPMENT

No cost impact analysis of the steel industry can ignore the ADL study for the AISI. This study represents perhaps the first comprehensive evaluation of the capital expenditures and operating costs associated with environmental regulations. To facilitate comparisons with studies such as that by ADL, PTm(Steel) has been designed to accept those engineering cost estimates as well as the estimates prepared for EPA.

At first glance, the above-mentioned capital expenditures for process-related water pollution control equipment appear to be comparable to those published by ADL, if capital expenditures for replacement facilities are excluded.[5] ADL estimates capital expenditures for water pollution control to be $3.5 billion for existing facilities and $0.9 billion for new facilities based on a pro rata share of total expenditures for new facilities. Utilizing NUS/Cyrus Rice engineering cost estimates, comparable TBS estimates of capital expenditures total $4.3 billion--$1.5 billion for pollution control equipment placed into service prior to 1975 and $2.8 billion for additional facilities required to meet the standards of the Water Act.[6]

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[5] *One-half of the ADL $4.9 billion estimate of capital expenditures for pollution control on new facilities represents replacement facilities; that is, new capacity which replaces existing capacity being retired.*

[6] *An estimate of initial capital investment based upon the NUS/Cyrus Rice costing methodology and engineering cost estimates, as reported in Table 79 of the Phase I Document and in Table 197 of the Phase II Document, would be $2.4 billion in 1975 dollars. This differs significantly from the comparable estimate utilizing the TBS methodology and NUS/Cyrus Rice*

The estimates by TBS are not directly comparable to those of ADL since they differ in the underlying forecasts of steel shipments, in the adjustment for commingling of waste streams, in the computation of expenditures for in-place facilities, and in the inclusion of construction work in progress. After these adjustments are made to place the capital expenditures on a comparable basis, the ADL estimate of additional expenditures during the 1975-1983 period exceeds the TBS estimate by $0.9--$3.4 vs. $2.5 billion. Exhibit 12 provides a detailed comparison of these alternative estimates of capital expenditures.

A process-by-process comparison of cost impacts indicates significant differences for coke ovens and blast furnaces apparently due to differing equipment design to meet the same criteria. In addition, differences in the engineering cost estimates for finishing mills can be explained partially by the more stringent Phase II guidelines analyzed by NUS/Rice.

The above summary of capital expenditures excludes the ADL estimate of requirements for replacement facilities. ADL estimated that $0.9 billion would be required to bring replacement facilities into compliance with the effluent guidelines. Such an estimate could be consistent with the ADL methodology wherein an estimate of capital expenditures for pollution control equipment placed into service prior to 1975 was based upon actual industry expenditures without consideration of whether the equipment in place is in compliance with the effluent guidelines. On the other hand,

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engineering cost estimates for four reasons which, in order of importance, are: (1) the TBS estimate is based upon 1983 capacity, the NUS/Cyrus Rice estimate upon 1972 production levels; (2) the TBS estimate recognizes economies of scale, the NUS/Cyrus Rice estimate does not; (3) the TBS estimate includes construction work in progress, the NUS/Cyrus Rice estimate does not; and (4) the TBS estimate utilizes the AISI inventory of 1972 capacity and the baseline forecast of domestic shipments, the NUS/Cyrus Rice estimate employs its own inventory of process units; and (5) the TBS estimate is in 1975 constant dollars, the NUS/Cyrus Rice estimates uses August 1972 dollars.

these expenditures for replacement facilities are inconsistent with the TBS methodology which bases expenditures for equipment in place upon the NUS/Cyrus Rice estimate of the proportion of existing facilities which are in compliance with the BPCTCA and BATEA requirements. Thus, TBS calculations presume that a steel company would not bring an existing facility into compliance only to retire or replace that facility during the 1975-1983 period.

Exhibit 13 provides a detailed comparison of operations and maintenance expenses based upon NUS/Cyrus Rice and ADL engineering cost estimates. Once again, significant differences were found between the estimates for coke ovens and blast furnaces.

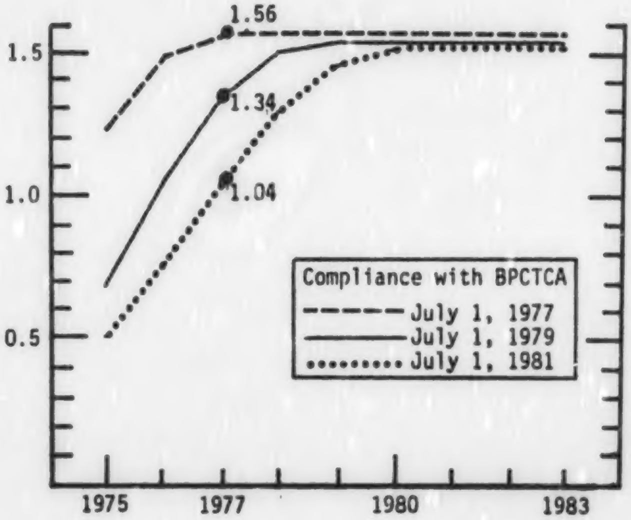
Another area of significant difference in engineering cost estimates is the storm runoff guideline. The ADL estimate of capital expenditures ranges from $0.8 to $2.8 billion; whereas the estimate based upon NUS/Cyrus Rice engineering costs is only $0.15 billion. This difference emanates from two basic sources. First, ADL assumed that the runoffs from the entire plant site must be contained and treated. The Phase II guideline requires containment and treatment from only coal, ore, and limestone piles. Second, there are major differences in the engineering assumptions regarding the magnitude of the storm for which facilities would be designed. These distinctions probably result from the fact that all ADL water pollution control cost estimates were based upon compliance with a draft standard which was subsequently revised.

SENSITIVITY ANALYSIS: BPCTCA COMPLIANCE SCHEDULE

While the statutory compliance schedule for the BPCTCA guideline is July 1, 1977, the previous analysis has been based upon a compliance schedule wherein all facilities achieve BPCTCA requirements by July 1, 1979. TBS has also analyzed the impact of full BPCTCA compliance by July 1, 1981 as well as the statutory date of July 1, 1977.

The annual stream of capital expenditures during the 1975-1983 period for these alternative schedules is as follows:

CUMULATIVE CAPITAL EXPENDITURES FOR
ALTERNATIVE BPCTCA COMPLIANCE DATES
(billions of 1975 dollars)



In the long run, total capital expenditures differ marginally as a result of timing differences in cash outlays.

As might be expected, however, compliance dates significantly affect the short-run capital expenditures. Full BPCTCA compliance by 1977 requires short-run capital expenditures of $1.6 billion. However, since full compliance is not expected until sometime between July 1979 and July 1981, actual short-run capital expenditures are expected to be between $1.3 and $1.0 billion.

The external financing implications of these alternative compliance schedules are analyzed in Section 7 of this report.

4. COST IMPACT OF CLEAN AIR ACT AND OTHER AIR POLLUTION REGULATIONS

The Clean Air Act of 1970 (P.L. 91-604, hereinafter referenced as the Air Act), establishes authority and regulatory responsibility in the area of air emission standards. The Air Act's objectives are protection of public health and welfare. For stationary point sources, such as steel industry facilities, direct responsibility lies with the states. EPA designates pollutants to be controlled and approves state initiated implementation plans. Implementation is to be accomplished in two stages--improvement to Primary Air Quality Standards by July 1, 1975 and to Secondary Air Quality Standards as soon as possible thereafter.

Each state must develop implementation plans to achieve, maintain, and enforce the emission standards for existing sources. Most state plans were approved by 1972; however, several factors have combined to delay compliance in some areas. First, some states such as New York have delayed the date for compliance in their implementation plans. Second, federal courts have stayed portions of the implementation plans for some states (e.g., Ohio and Maryland). Third, portions of some implementation plans have not yet been approved by EPA. Finally, implementation has been delayed in some cases due to litigation by steel firms.

The statutory compliance date for Primary Air Quality Standards is July 1, 1975. Recognizing the abovementioned delays, the following analysis has been based upon compliance with the stack emission standard by July 1, 1978 and the fugitive emission standard by July 1, 1980.

New Source Performance Standards (NSPS) apply to all facilities where construction is begun after proposal of the NSPS standard. Emission standards for new sources are established by the EPA administrator. These standards must employ "the base system of emission reduction which (taking into account the cost of achieving such reduction) the Administrator determines has been adequately demonstrated." Though new source standards have been specified for some processes such as electric arc furnaces, standards for other processes may not be proposed for several years. New facilities constructed before proposal of new source standards must meet the applicable requirements under the state implementation plan.

COSTING METHODOLOGY

Due to the varying and complex standards set by individual states, no engineering cost analysis of compliance based upon equipment specified by each state has been performed. Available cost data are based on published reports regarding equipment which may exceed or fall short of the required standards. In the area of new source standards, states may supersede EPA standards with more stringent controls. Hence, as with the existing source costs, there is a lack of precise cost data for new source standards.

The 1974 Cost of Clean Air report prepared for EPA by Battelle Columbus Laboratories has been used as the basis for projecting cost impacts for stack emission standards.[1]

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[1] *Some engineering cost data reported in the 1974 Cost of Clean Air and used herein were obtained from A Systems Analysis of the Integrated Iron and Steel Industry, Battelle Columbus Laboratories, 1969.*

Unlike water pollution control costs which were based on a specific treatment model, Battelle cost estimates are based on published data for equipment with varying specifications.

Engineering cost estimates for equipment to meet fugitive emission standards were supplied by the EPA Standards and Cost Analysis Branch in Durham, North Carolina. These cost estimates relied upon ADL engineering cost equations and assumed EPA air flow rates.

Utilizing these cost equations, the AISI inventory of steel facilities by process, and the schedule of compliance described above, TBS performed a detailed analysis of the cost impacts associated with the Air Act. These costs have been analyzed within the context of the previously described steel industry baseline conditions to determine the economic impact of environmental regulations. Process level detail on air pollution control costs are contained in Appendix D.

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT

Capital expenditures for air pollution control equipment during the period 1975 to 1983 are estimated as follows:

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Stack Emissions	$1.33	$1.65
Fugitive Emissions	0.63	1.34
Other Air	0.13	0.26
TOTAL	$2.09	$3.25

These capital expenditures are detailed for each stage of production by time period and by emission standard in Exhibits 14 and 15, respectively.

Of the $3.2 billion of capital expenditures required for air pollution control equipment in the long run, about two-thirds will be expended during the 1975-1977 period. Requirements in the short run are much larger than in the long run due to related increases in construction work in progress. Nearly $1.1 billion of the $2.1 billion required in the short run represents increases in construction work in progress. Almost two-thirds of the funds expended in the short run are required for stack emissions. Fugitive emissions account for 40 percent of capital expenditures in the long run.

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

Operations and maintenance expenses required to operate air pollution control equipment placed into service during the period 1975-1983 are summarized below:

OPERATIONS & MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Stack Emissions	$0.19	$0.96
Fugitive Emissions	-	1.15
Other Air	0.02	0.22
TOTAL	$0.21	$2.34

Total operations and maintenance expenses are tabulated for each stage of production by time period and by emission standard in Exhibits 16 and 17, respectively. These exhibits include O&M expenses for air pollution control equipment placed into service prior to 1975. The above table represents only O&M expenses for equipment placed into service during the 1975-1983 period. Expenses for air pollution control equipment installed prior to 1975 were detailed in Exhibit 7.

Operations and maintenance expenses of $0.4 billion in the short run are split nearly equally between in-place and new equipment. In the long run, only 22 percent of the $3.0 billion total for air pollution control is attributable to equipment placed into service prior to 1975. In 1983, when all air treatment facilities are in operation, O&M expenses for air pollution control facilities installed during the 1975-1983 period exceed $0.4 billion. On-site raw materials preparation represents nearly 50 percent of air pollution control costs. These costs are entirely attributable to sintering and coking.

COMPARISON OF ALTERNATIVE ENGINEERING COST ESTIMATES FOR AIR POLLUTION CONTROL EQUIPMENT

The ADL study represents the most recent and complete study of air pollution control costs done outside EPA. In order to facilitate comparisons, PTm(Steel) has been designed to accept alternative engineering cost estimates, such as the costs in the ADL study.

An initial comparison of capital expenditures and operations and maintenance expenses indicates significant differences in the findings of ADL and this study. Estimated capital expenditures for air pollution control in this study are $3.9 billion, including expenditures for equipment installed prior to 1975. The comparable estimate from the ADL study is $6.9 billion, including a pro rata share of expenditures for new facilities, but excluding expenditures for replacement facilities.[2]

Capital expenditures estimated by using ADL engineering cost estimates in PTm(Steel) total $6.7 billion in the long run. Differences in the capital expenditures estimated in this manner and those reported by ADL reflect alternative assumptions regarding steel shipments and cost escalation factors.

Given the ability of PTm(Steel) to reproduce ADL costs, the results from PTm(Steel) with ADL engineering cost estimates can be compared to PTm(Steel) results utilizing Battelle Columbus Laboratories and EPA engineering cost estimates. When these estimates of capital expenditures are placed on a comparable basis, the ADL estimate for the 1975-1983 period is more than double the estimate based upon Battelle and EPA engineering cost assumptions--$6.7 billion vs. $3.3 billion. This comparison of air pollution control costs by stage of production is detailed in Exhibits 18 and 19.

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[2] *The alternative assumptions for replacement facilities are discussed on pages 3-9 and 3-10.*

More than 90 percent of the difference between ADL and EPA cost effects, for both capital expenditures and operations and maintenance expenses, results from different assumptions for the control of fugitive emissions. While EPA engineering cost estimates are based upon the same cost relationships as ADL for a given air flow, EPA assumes that considerably lower air flows will be required to achieve fugitive emissions control and that approximately 65 percent of open hearth furnaces presently installed will not be fitted with fugitive emissions control equipment.

5. SUMMARY OF THE COST IMPACTS OF ENVIRONMENTAL REGULATIONS

The economic impact of environmental regulations can be summarized by focusing on five key indicators: capital expenditures, operations and maintenance expenses, external financing needs, revenue requirements, and average price levels. Of these, the first two have been considered independently for water and for air in the previous two sections. The combined cost of air and water pollution control in terms of both capital expenditures and operations and maintenance expenses will be summarized in this section. From these combined costs, subsequent sections will evaluate the economic impact of environmental regulations in terms of the remaining indicators.

Expenditures for water and for air pollution control are additive to the baseline which includes expenditures for equipment installed prior to 1975. That is, total expenditures are the sum of these two categories and the baseline.

CAPITAL EXPENDITURES

Capital expenditures for pollution control and baseline are combined as follows:

COMBINED CAPITAL EXPENDITURES FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT AND BASELINE REQUIREMENTS

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Baseline	$8.72	$27.50
Pollution Control Equipment		
Water	1.78	3.58
Air	2.09	3.25
TOTAL	$3.85	$6.83
GRAND TOTAL	$12.56	$34.32
Pollution Control as Percent of Baseline	44.0%	24.8%

Capital expenditures are expected to total $34.3 billion during the period 1975 to 1983, an average of $3.8 billion per year. The annual amount is somewhat higher in the near term and lower at the end of the period. The $3.8 billion average yearly expenditure is significantly above the $2.6 billion per year (in constant 1975 dollars) expended on average by the steel industry for all purposes during the last decade.

Air and water pollution control combined represents $6.8 billion in capital expenditures from 1975 to 1983. Over one-half, $3.8 billion, of this amount is required in the short run (1975-1977). Capital expenditures will be incurred at the rate of $1.3 billion per year for the remainder of the period. This bias toward early expenditures is caused by the need to meet compliance schedules and the associated increases in both equipment in service and construction work in progress. Over 50 percent of short-run capital expenditures are for increases in construction work in progress, while in the long run, this figure drops to 12 percent.

Capital expenditures for pollution control represent over 40 percent of total short-run needs and almost 25 percent of long-run needs. In the previous nine years, capital expenditures for pollution control equipment placed into service by the steel industry totaled $1.7 billion in constant 1975 dollars--only 7 percent of capital expenditures during this period.[1]

OPERATIONS AND MAINTENANCE EXPENSES

Combined operations and maintenance expenses for the baseline, water, and air pollution control are tabulated below:

COMBINED OPERATIONS AND MAINTENANCE EXPENSES FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT AND BASELINE REQUIREMENTS
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Baseline	$78.17	$282.87
Pollution Control Equipment		
Water	0.19	2.54
Air	0.21	2.33
TOTAL	$0.40	$4.87
GRAND TOTAL	$78.56	$287.74
Pollution Control as Percent of Baseline	0.5%	1.7%

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[1] *Steel Industry Economics and Federal Income Tax Policy*, *op.cit.*

O&M expenses are dominated by production costs. Of the $287.7 billion of O&M expenses incurred from 1975 to 1983, air and water pollution control combined represent only 1.7 percent. However, these cumulative amounts understate somewhat the long-run effect of pollution control O&M expenses since only part of the equipment is in operation throughout the period. In 1983, when all facilities are in compliance with pollution control requirements, the pollution control equipment added from 1975-1983 will represent 2.8 percent of total O&M expenses.

6. ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS: REVENUE REQUIREMENTS AND PRICE EFFECTS

Thus far the discussion of the effect of environmental regulations has focused on capital expenditures and operations and maintenance expense. In order to evaluate fully the economic impact of environmental regulations on the industry, these capital expenditures and O&M costs must be converted to revenue requirements, related price effects, and external financing needs.

Most studies of the steel industry focus on the cost impacts of expansion, modernization, and environmental regulations and their aggregate financing requirements by extrapolating historical cash flows. Such an approach, while perhaps providing insight into future conditions within the industry, seems valid only insofar as the economic, regulatory, and industry conditions of the recent past are essentially unchanged in the future. Given that the last five years have included periods of high inflation, limited capacity expansion, price controls, record shipments and profit levels, worldwide steel shortages, dollar devaluation (and revaluation), significant inventory accumulation (and depletion) and a deep recession, it is highly unlikely that events of a similar nature will be equally important during the 1975-1983 period.

The TBS methodology avoids a dependence on the assumption that past industry trends will continue by building up projections of revenue requirements, cash flows, and external financing needs from a series of explicit assumptions about future industry shipments, capital and operating costs per ton of existing and new capacity, and rates of return on investment. Revenue requirements within PTm(Steel) are defined as the recovery of all costs, including a target rate of return on common equity. These costs include operating expenses, depreciation, sales and property taxes, interest income and expenses, federal and state income taxes, and net income requirements. Since some of these costs vary with economic and regulatory conditions, TBS has performed sensitivity analyses on key economic and financial parameters.[1] A schematic diagram of the revenue requirements module within PTm(Steel) is provided in Exhibit 20.

Once revenue requirements have been determined, an average price effect can be computed by dividing the above-mentioned revenue requirements in any given year by domestic steel shipments.[2] Given the level of detail captured with PTm (Steel), these average price effects can be computed on an overall basis, by product and stage of production, or by value added at each stage within the steel production process.

Additional detailed findings on revenue requirements and price effects can be found in Appendix E.

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[1] *Perhaps the most controversial revenue requirement is that associated with the target rate of return on common equity. In order to determine the impact of this key parameter, TBS analyzed rates of return equal to those historically observed for all manufacturing firms, for steel firms overall, and for steel operations by major steel companies. Baseline conditions include net income requirements based upon a real (i.e., adjusted for inflation) rate of return equal to 3.5 percent, the real rate of return realized overall by steel firms during the last decade.*

[2] *During a period of increasing capacity requirements and increasing costs of capacity expansion, the revenue per ton required to earn the target rate of return on common equity employed for capacity expansion would exceed the revenue per ton required to earn the same rate of return for existing capacity. It should be noted that the price effect defined herein would, on average, provide the target rate of return on common equity.*

REVENUE REQUIREMENTS

During the 1975-1983 period, baseline revenue requirements are anticipated as follows:

REVENUE REQUIREMENTS FOR
BASELINE CONDITIONS
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Sales Taxes	$ 3.82	$ 13.44
Operations & Maintenance Expenses	78.17	282.87
Capital Related Costs		
Depreciation	$ 4.31	$ 13.70
Property Taxes	0.92	3.15
Net Interest Expenses	1.26	4.41
Income Taxes	2.57	7.06
Net Income Requirement	5.07	13.92
SUBTOTAL	$14.13	$ 42.30
Revenue Requirements	$96.11	$338.61

Required revenues, without consideration of additional pollution control equipment, will amount to $96.1 billion in the short run and $338.6 billion in the long run. These baseline revenue requirements will approximate $32.0 billion per year during the 1975-1977 period and are expected to increase to $37.6 billion per year in the long run. Of these revenue requirements, more than 80 percent represent operating costs. The remaining revenues are associated with capital-related charges with the exception of sales taxes which are about 4 percent of revenues.

In computing required revenues, PTm (Steel) details costs by category and attributes these costs to their appropriate sources. Revenue requirements associated with environmental regulations are as follows:

REVENUE REQUIREMENTS FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Water Pollution Control Equipment		
Phase I Processes	$0.11	$ 0.98
Phase II Processes	0.53	3.25
Sub Total	$0.64	$ 4.23
Storm Runoff	*	0.20
Other Water	0.07	1.32
Water Total	$0.73	$ 5.75
Air Pollution Control Equipment		
Stack Emissions	$0.69	$ 2.78
Fugitive Emissions	0.10	2.44
Other Air	0.07	0.47
Air Total	$0.86	$ 5.68
GRAND TOTAL	$1.59	$11.43

*Less than $5 million

Exhibits 21 and 22 provide revenue requirements allocated to baseline conditions and water and air pollution control equipment by cost category for the 1975-1983 period and by source of requirement by time period, respectively.

Additional revenues for the water and air pollution control equipment required to meet effluent guidelines, emission standards and miscellaneous environmental regulations will approximate $1.6 billion in the short run and $11.4 billion in the long run. These increases in required revenues amount to 1.6 percent of the baseline in the short run and 3.4 percent in the long run.

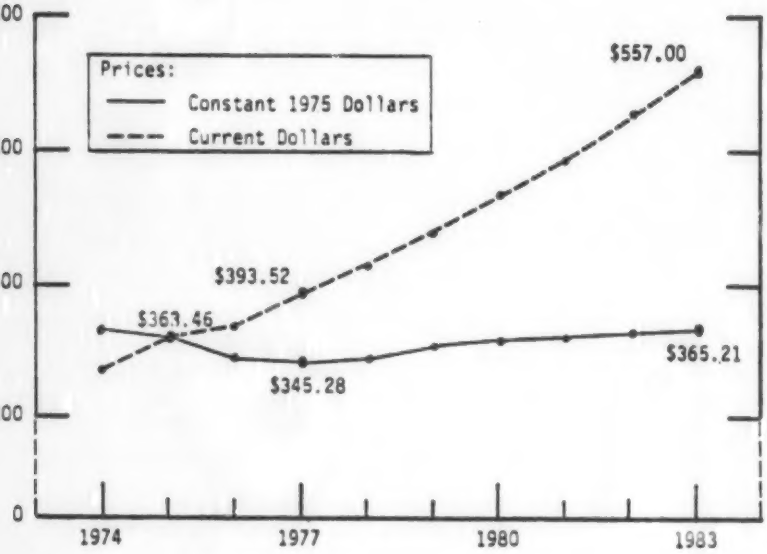
Thus more than $0.5 billion per year in additional costs will need to be recovered during the 1975-1977 period. These annual revenue requirements will continue to increase as more pollution control equipment is added. By 1983 the impact will be nearly $2.0 billion per year. During the 1975-1983 period, revenues required due to the addition of pollution control equipment will average $1.3 billion per year.

The major component of these added revenue requirements is capital-related charges. Depreciation and other capital-related costs account for more than 50 percent of the long-run increase in revenue requirements. Of the total $11.4 billion associated with pollution control equipment in the long run, $3.0 billion represents earnings before income taxes--an amount which would permit the steel industry to achieve its historical rate of return on common equity.

PRICE EFFECTS

Average steel prices can be determined by dividing revenue requirements by the appropriate level of steel shipments. For example, the baseline price per ton of domestic steel shipped during 1975 is estimated to have averaged $363.46. This average price is expected to decline in real terms (i.e., adjusted for inflation) through 1977 due to continued productivity gains and increasing capacity utilization factors. However, sectoral inflation in the labor and basic raw material markets is expected to result in a real increase in long-run prices. In real terms, the average baseline price level anticipated in 1977 is $345.28. By 1983 the baseline price is expected to increase to $365.21 in real terms.[3,4] Baseline price levels, in both nominal and real terms, are as follows:

BASELINE PRICE LEVELS



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[3] These baseline prices include a charge of $4.11 per ton in 1977 and $3.25 per ton in 1983 which is associated with the continued operation of pollution control equipment placed into service prior to 1975.

[4] Once again, the baseline price would, on average, provide the target rate of return on common equity. A 1983 baseline price of $387.18 would be required to yield the specified return on the common equity needed for incremental investment beyond rounding out existing steel finishing capacity. This occurs because investment in new facilities is more costly per unit of production than the present accounting value of existing plants. At this price level, the rate of return for existing capacity would be significantly higher than the target.

Pollution control equipment placed into service during the 1975-1983 period is expected to increase the average 1983 real price per ton of steel from $365.21 to $381.96, an increase of $16.75 per ton as follows:

AVERAGE PRICE EFFECTS FOR WATER AND
AIR POLLUTION CONTROL EQUIPMENT
(1975 dollars per ton)

	Short-Run 1977	Long-Run 1983
Water Pollution Control Equipment		
Phase I Processes	$ 0.56	$ 1.76
Phase II Processes	2.46	4.22
Sub Total	$ 3.02	$ 5.98
Storm Runoff	0.02	0.53
Other Water	0.38	3.09
Water Total	$ 3.42	$ 9.60
Air Pollution Control Equipment		
Stack Emissions	$ 2.98	$ 2.70
Fugitive Emissions	0.54	3.70
Other Air	0.30	0.75
Air Total	$ 3.82	$ 7.15
GRAND TOTAL	$ 7.24	$16.75

As previously mentioned, PTm(Steel) permits the computation of the price per ton on an overall basis (Exhibit 23), by steel product (Exhibit 24), by stage of production (Exhibit 25), and by value-added at each process (Exhibit 26). These exhibits segment the 1983 price into the components associated with baseline conditions and water and air pollution control equipment. In addition, overall price levels are provided for selected years (1974, 1977, 1980 and 1983) to permit a computation of price trends with and without environmental regulations.

By 1977, pollution control requirements will increase prices by 2.1 percent, with more than one-half of this increase associated with air pollution control. In the long run, environmental regulations will increase prices by 4.6 percent, with water pollution control equipment responsible for a 2.6 percent increase.

Some industry observers would conclude that these price increases would have a negative impact upon steel shipments. However, the bulk of steel costs are still represented by the baseline costs and with continued increases in efficiency, steel prices, measured in 1975 dollars, will approximate $382 per ton by 1983, up approximately $16 from comparable price levels recorded in 1974. Thus, while steel prices will increase due to environmental regulations, steel customers will face increases in nominal steel prices which will exceed the rate of overall inflation within the economy by only 0.5 percent. The potential negative effect on steel shipments is probably within the range of the lower projection of steel shipments used in this analysis.

When price effects are evaluated by steel product, they vary widely. In dollar terms, the price increases range from $7.99 per ton for direct shipments of semi-finished products to $25.31 for nails and other wire products. In percentage terms, the increases range from 3.5 percent for direct shipments of semi-finished products to 5.6 percent for cold finished bars. The cost of water pollution control varies widely from one finishing process to another. Since each product requires processing by a different combination of finishing mills, the price effect varies widely by product also. On the other hand, air emission standards primarily concern iron and steelmaking processes (including coke ovens) which are common to all products and thus, tend to add constant dollar amount per ton to all finished products.

When price effects are computed for each process, the most significant effects are associated with coke ovens where the 1983 cost of coke is expected to increase by more than $8 per ton.[5] Emission standards will also adversely affect all furnace costs, with open hearth and electric furnaces incurring added costs of more than $3.50 per ton. Effluent guidelines impact all processes, but the finishing processes represent more than 50 percent of the total impact for water pollution control equipment.

SENSITIVITY ANALYSIS: ALTERNATIVE BASIC RAW MATERIAL COSTS

A major factor in the determination of overall price levels is the assumption regarding basic raw material costs. The above-mentioned analysis of baseline conditions includes iron ore, metallurgical coal, and scrap metal prices specified at market values which reflect sectoral inflation, declining productivity in underground coal mines. Scrap metal prices are keyed to the cost of hot metal since over a reasonable range, these two are substitutable.

In order to determine the impact of alternative basic raw material costs, TBS analyzed a set of conditions wherein iron ore, metallurgical coal, and scrap metal prices escalate from observed 1972 prices by the price/cost indices forecast by Data Resources, Inc.[6] Utilizing these raw material costs, baseline prices would approximate $317 per ton in 1977 and $313 per ton in 1983. These average prices would represent a significant decline from the above-mentioned baseline steel prices of $345 per ton in 1977 and $365 per ton in 1983.

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[5] *This estimate of the price effect for coke ovens ignores the OSHA requirements recently proposed. It should also be noted that ADL's estimate of cost impacts on coke ovens was significantly greater than those based upon NUS/Rice engineering cost estimates.*

[6] *"Steel Raw Materials Long-Term Forecast," DRI Steel Forecast Service, summary 1975.*

SENSITIVITY ANALYSIS: LESS THAN FULL COST PASS-THRU

Analyses of revenue requirements and prices have thus far assumed that the steel industry is able to recover all the costs associated with pollution control abatement, including a target rate of return on common equity equal to that earned on productive assets. Some industry observers would seriously question this assumption, arguing that import competition or government regulation will constrain the industry's ability to pass through these costs.

In an effort to evaluate the economic implications of less than full cost pass-through, TBS computed revenue requirements, price effects and external financing needs under the assumption that the costs of pollution control equipment are not passed through to steel customers.

As previously discussed, revenue requirements for water and air pollution will total $11.4 billion in the long run. If these costs were not passed through, approximately 65 percent would be absorbed by reductions in net income. The remaining 35 percent would reduce income taxes. These costs would reduce the previously cited baseline net income of $13.9 billion by more than one-half This reduction in net income represents approximately a 2 percent decline in industry revenue requirements. Since O&M costs and capital charges are about equal, the effect of passing through only one is about one-half of the total.

SENSITIVITY ANALYSIS: ALTERNATIVE RATES OF RETURN ON EQUITY

Throughout this study, TBS has considered net income, or the return on common equity, as a cost of doing business. This approach recognizes that a relatively capital intensive industry like the steel industry must be able to earn a competitive rate of return on its investment so that it can attract new capital to finance its growth.

During the last decade the steel industry did not expand its capacity and raised less than $1.0 billion in external financing. However, if domestic steel shipments are to keep pace with historic growth trends, the steel industry must expand during the next decade and must attract substantial amounts of external financing.

In an effort to determine the revenue requirements and price effect of alternative rates of return on equity, TBS analyzed rates of return equal to those historically observed for all manufacturing firms, for steel firms overall, and for steel operations by major steel companies.

Manufacturing firms have achieved average rates of return of 7 percent in real terms (adjusted for inflation) during the last decade. During the same period steel firms have been able to earn only 50 percent of this rate. Unfortunately, steel firms have been able to maintain even this lackluster profitability only by diversifying into non-steel ventures and integrating backward into mining and/or forward into fabrication, bridge building, ship building, etc.

While the profitability of steel operations is not detailed in annual financial statements, major integrated steel firms, representing more than 50 percent of raw steel production, have provided data to TBS through the AISI on the profitability of steel operations. From 1972 through the first nine months of 1975, steel operations within these major steel producers have realized real rates of return of minus 1 percent. That is, these operations would have operated at a loss if raw materials were purchased at market value rather than transferred from another division within the firm.

Any reduction in steel prices below the baseline levels previously cited would reduce profitability, would increase the industry's financing needs, and would decrease the likelihood that these funds could be attracted to the steel industry at acceptable terms. A more thorough discussion of the economic impact associated with operating steel facilities at a loss follows in the next section of this report.

If steel firms were able to increase their profitability from existing levels overall to the average of all manufacturing firms, baseline prices would need to increase by about 3 percent in both the short and long run. These price increases would flow through to net income and would increase retained earnings by more than 30 percent in the long run. This increase in the target rate of return on common equity would increase the price effect associated with pollution control equipment from 4.6 percent to 4.9 percent. As will be discussed in the next section, increased profitability will not only reduce the financing requirements of the industry in absolute terms, but also increase the attractiveness of its financing instruments in the capital markets.

SENSITIVITY ANALYSIS: PRICE AND INCOME ELASTICITY

Most economists attempt to evaluate economic impact within the context of the classical supply and demand model and its assumptions regarding price and income elasticities and cross-elasticities. Unfortunately, these kinds of elasticity estimates are not readily available for the steel industry, especially at the level of steel products; hence, elasticity estimates have not been utilized explicitly in this study. However, those estimates which do exist suggest that the demand for steel is relatively inelastic for the small range of price changes implied in this study.

7. ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS: EXTERNAL FINANCING NEEDS

Once revenue requirements have been determined, external financing requirements can be computed as the difference between total applications and internal sources of funds. Capital expenditures for capacity expansion and modernization, including increases in construction work in progress, dominate baseline applications; however PTm(Steel) also includes changes in working capital and refundings of long-term debt. Internal cash flows include depreciation charges and retained earnings.

External financing needs are met through issues of long-term debt and common stock. The mix of debt and equity issues is based upon the maintenance of a historic capital structure. Exhibit 20 summarizes these flows within the financing module by means of a schematic diagram. More detail regarding the findings presented in this section can be found in Appendix F.

The industry's uses of funds and sources of funds, including external financing, are summarized in the following table:

BASELINE SOURCES AND APPLICATIONS OF FUNDS

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$ 8.72	$27.50
Increase in Working Capital	1.15	4.21
Refunding of Long-Term Debt	0.47	1.22
TOTAL APPLICATIONS	$10.34	$32.93
Depreciation	$ 4.31	$13.76
Retained Earnings	2.25	6.18
Internal Sources	$ 6.56	$19.94
Issues of Long-Term Debt	$ 2.29	$ 6.19
Issues of Common Stock	1.49	6.79
External Financing	$ 3.77	$12.99
TOTAL SOURCES	$10.34	$32.93

Exhibits 27 and 28 provide sources and applications of funds for the industry baseline and for pollution control equipment in the short and long run, respectively.

In the short run, total baseline applications of funds are expected to be $10.3 billion, of which nearly $6.6 billion will be generated internally through depreciation and retained earnings. The remainder, nearly $3.8 billion, must be obtained from the capital markets in the form of new issues of long-term debt and common stock. These external financing requirements in the short run will be nearly $1.3 billion per year. In the long run the external financing needs are projected to be $13.0 billion, an average of $1.4 billion per year.

During the last decade the steel industry has depended upon external sources for less than $1.0 billion.[1] These external financing requirements represented only 5 percent of total applications. The $13.0 billion of external financing required in the long run represents nearly 40 percent of total baseline applications. Thus the steel industry must attract significant amounts of capital to finance expansion and modernization of steel operations after more than a decade of negligible financing activity. Environmental regulations will increase these financing requirements.

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[1] *In fact, internal sources exceeded total applications by nearly $0.6 billion during 1973 and 1974.*

Financing pollution control equipment during the 1975-1983 period will require more than $4.5 billion in external financing. These requirements are as follows:

EXTERNAL FINANCING REQUIREMENTS FOR
WATER AND AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Water Pollution Control Equipment		
Phase I Processes	$ 0.24	$ 0.48
Phase II Processes	1.18	1.39
Sub Total	$ 1.42	$ 1.87
Storm Runoff	0.02	0.12
Other Water	0.15	0.49
TOTAL	$ 1.59	$ 2.49
Air Pollution Control Equipment		
Stack Emissions	$ 1.16	$ 0.93
Fugitive Emissions	0.62	0.95
Other Air	0.12	0.18
Sub Total	$ 1.90	$ 2.06
GRAND TOTAL	$ 3.49	$ 4.55

Exhibit 29 details these external financing needs by time period.

More than two-thirds of the capital expenditures required for pollution control must be obtained from external financing. This requirement increases total external financing needs by 35 percent in the long run.

The most serious financing problem, however, exists in the short run. Environmental regulations will require $3.5 billion, a near doubling of the financing requirements for expansion and modernization. Nearly 90 percent of the funds associated with pollution control must be financed in the short run through external sources.

These 1975-1977 capital market requirements may pose serious problems for the steel industry. These external financing requirements far exceed historical flows. The 1972-1974 period was the most prosperous period in the history of the steel industry. During these years, the industry was able to generate $7.1 billion from internal sources for all of its activities--steel operations, mining, fabrication, non-steel operations, etc.--and had applications of less than $6.7 billion. By way of comparison, the above-mentioned total requirements for steel operations alone during the 1975-1977 period total $14.3 billion in applications and $7.3 billion in external financing. Thus, total uses of funds are expected to more than double, with internal sources increasing marginally from $6.7 to $7.0 billion. The net result is a significant gap to be filled by issues of long-term debt and common stock.

If the industry's profitability trends of the recent past continue, these external financing requirements may be particularly difficult to meet. The industry's level of profitability has seriously lagged the average of all manufacturing with the exception of 1974 when the relaxation of price controls and worldwide shortages of both steel and basic raw materials enabled the steel industry to raise its prices and fully utilize its productive capacity. Overall steel industry rates of return in 1974 equalled the all-manufacturing average, with natural resources extraction and some non-steel activities (e.g., chemicals) far exceeding the returns on steel operations. Over the last decade, however, the steel industry's rate of return on common equity has averaged one-half of that for all manufacturing firms when profitability is adjusted to reflect inflationary trends.

The steel industry in the past has been burdened with a poor assessment by financial analysts and investors in general. During the last decade, the industry has not expanded its capacity and, therefore, has not required infusions of capital. This static operating environment, when coupled with a dismal record of profits, helps to explain the industry's performance in the stock market. From 1970 through 1974 the ratio of market value to book value for the six major integrated steel firms approximated 0.5.[2] That is, investors have valued the industry's securities at one-half the amount which these securities would yield if the industry could liquidate its assets at book values. If the steel industry were required to issue common stock to finance its expansion and/or pollution control equipment under these capital market conditions, the value of the holdings by existing stockholders would be diluted, thus discouraging further investment. Unless stock prices increased to a level approximating book value, the need for continued financing in the long run would discourage investors in the short run.

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[2] *The stock market recovery during the 1st Quarter of 1976 has significantly improved the ratio of market values to book values for steel firms. The first new common stock issue by a major integrated steel firm since the 1950s was offered on March 29, 1976 by Inland Steel. This improvement is not, however, significant enough to alter the findings of this report.*

If steel firms are unwilling to issue common stock at prices below book value, they could attempt to increase their historical equity ratio of 30-40 percent. However, if the industry were to finance its expansion of pollution control equipment needs entirely with long-term debt issues, its debt to equity ratio would increase to 100 percent by 1983. If feasible at all, such a financing plan would almost certainly reduce the industry's bond ratings and increase its net costs by a significant amount. This prospect might well lead most steel firms to cut back on their capacity expansion plans.

The above-mentioned analysis does not necessarily imply that the steel industry cannot finance its expansion and its pollution control requirements in the short run. While there is little doubt that financing these requirements will be extremely difficult, TBS believes that the task is manageable. However, the industry must be able to pass through the increased operating costs and capital-related charges associated with expansion, modernization, and environmental regulations. In addition, the industry must be able to earn a competitive return on its common equity. This rate of return would presumably be at least comparable to that realized by other manufacturing firms.

Several obstacles stand in the way of the steel industry's meeting these conditions. The increased prices implied by the pass-through of all pollution control costs, including an adequate return on common equity, could adversely impact the ability of domestic producers to compete with imports and substitute materials. However, TBS projects that future prices will increase by less than 0.5 percent in real terms from 1974 levels. In addition, most knowledgeable observers of the steel industry believe that the domestic steel industry is now cost competitive with foreign steel producers. Future capacity expansion and the shift to more efficient steelmaking should increase this comparative advantage.

Over the last decade the steel industry has been unable to earn an adequate return. Foreign competition and domestic price controls combine severely to limit profitability. The termination of formal price controls and worldwide steel shortages, both of which took place in 1974, enabled the domestic steel industry to raise its prices and to earn a competitive rate of return. Given the current competitive position of domestic steel producers, an elimination of government restraints on price increases should permit the steel industry to achieve adequate rates of return without adversely impacting its ability to compete with foreign producers.

Some observers of capital market conditions have forecast a shortage of capital in the near future. While unwilling to state without qualification that capital market conditions will not restrict future economic growth, TBS believes that type overall capital market conditions are relatively unlikely in the time period covered by this analysis.

As is discussed in Appendix F, the availability of capital would be difficult for many sectors of the economy under some scenarios. However, even under stringent capital market conditions, major non-financial corporations should be able to meet their financing needs. Thus, unless the steel industry profitability is so low as to exacerbate tight capital market conditions, the major unanswered question is the cost of that capital rather than the availability. The capital availability question is most relevant to the marginal, interest-sensitive borrower. Normally, these borrowers would include state and local governments, small business firms, and individuals requiring home mortgages and/or consumer credit.

SENSITIVITY ANALYSIS: STEEL SHIPMENTS FORECAST[3]

Perhaps the most uncertain element in the set of industry conditions thus far analyzed is the forecast of the future level of steel shipments. In establishing its baseline forecast, TBS assumed that domestic steel shipments would rebound from the recession levels in 1975 to the long-run trend by 1977. Recognizing the sensitivity of capital expenditures and related external financing needs to this forecast of domestic steel shipments, TBS evaluated alternative forecasts of domestic steel shipments, including the following:

- shipments would recover from the current recession by 1977 and would exceed the long-run trend by 10 percent in subsequent years,
- shipments would not fully recover from the current recession and would remain permanently below the long-run trend by 10 percent, and
- shipments would recover more slowly from the current recession and would not reach the long-run trend until 1980.

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[3] *In earlier drafts baseline numbers in this section included the production and 1974 in-place pollution control increment for the period from 1972 to 1974. This increment has not been included in the final set of numbers.*

OPTIMISTIC FORECAST OF SHIPMENTS

The short-run financing problem uncovered in the previous analyses would be exacerbated if the industry growth were to exceed the long-run trend after 1977. Under these conditions capital expenditures for capacity expansion would be $13.0 billion in the short run, $7.8 of which would require external financing. Thus baseline capital expenditures would increase from $8.7 to $13.0 billion, or 49 percent, all in the form of an increase in construction work in progress. External financing requirements for capacity expansion and modernization would increase from $3.8 to $7.8 billion, an increase of more than 105 percent.

While the short-run incremental impact of pollution control equipment under this optimistic forecast of shipments would increase by less than 10 percent for capital expenditures and external financing, the combined requirements for capacity expansion, modernization and pollution control equipment under these conditions would be immense. Total short-run capital expenditures and external financing requirements would be $17.1 billion and $11.6 billion, respectively. On an annual basis, these capital expenditures would average $5.7 billion per year, $3.9 billion of which would be financed within the capital markets. These external financing requirements in the short run represent a 63 percent increase over the $2.4 billion per year required for the baseline case.

In the long run, the requirements of optimistic growth would be no less acute. Total capital expenditures would increase from $34.3 to $42.9 billion with external financing requirements increasing from $17.5 to $24.2 billion. While the industry's external financing requirements under optimistic growth assumptions would be of major magnitude, they are not necessarily infeasible. Presuming that the high rate of growth in shipments and capacity is accompanied by a high level of profitability, the industry's debt and equity securities could be accorded a favorable reception by investors. Moreover, the higher level of profitability would augment internal sources of funds, thereby reducing the industry's external financing needs. However, if the industry desired to finance a rapid rate of growth and cost expansion under conditions of moderate or low profitability, the capital markets might provide a substantial constraint to these desires. Under generally tight capital market conditions, the industry might be hard put to meet the financing needs associated with an optimistic rate of growth and shipments.

It is TBS's opinion that these optimistic growth requirements, coupled with the capital needs for pollution control equipment, would exceed the industry's financing abilities, especially in the short run.

PESSIMISTIC FORECAST OF SHIPMENTS

If the sharp decline in steel shipments during 1975 represents a permanent, structural shift away from steel products or toward lighter materials, whether it be thinner gauge steel or substitute materials, the short-run financing problem within the industry would be eased. Under these conditions total short-run capital expenditures would decline from $12.6 to $10.2 billion, a decline of nearly 20 percent. Related external financing requirements would decline from $7.3 to $5.2

billion, a decline in excess of 28 percent. Thus annual external financing needs, which averaged more than $2.4 billion under baseline conditions, would decline by $0.7 billion.

It is TBS's opinion that a combination of slower expansion of capacity, continued modernization of existing capacity, and compliance with environmental regulations would be quite manageable in both the short and long run.

SLOW RECOVERY FROM RECESSION

If the sharp decline in steel shipments during 1975 represents a temporary, but prolonged, setback for the steel industry, the previously mentioned short-run financing problem is somewhat eased. Under these conditions, total short-run capital expenditures decline from $12.6 to $12.3 billion, with a slightly greater decrease in external financing requirements. Since the slow recovery does not alter the long-run trend, no change in the long-run impacts is evident, with the exception of minor differences attributed to the timing of expenditures.

Weak demand would certainly exacerbate the poor economic assessment of the steel industry by many analysts. But if adequate levels of return on equity are achieved, it is TBS's opinion that capacity expansion, continued modernization of existing capacity and compliance with environmental regulations would be manageable.

SENSITIVITY ANALYSIS: PLANNING UNDER UNCERTAINTY

All of the above-mentioned sensitivity analyses assume that the steel industry is able to forecast future economic conditions with great accuracy and plan accordingly. A far more likely set of conditions would be those wherein the industry would plan for a rebound from the 1975 recession to the long-run trend in 1977, but the uncertainty in steel shipments would result in operations above or below those levels anticipated.

For example, the industry might expand to meet the long-run trend only to find that the 1975 recession represented a structural shift in steel consumption. Under these conditions, unit costs would increase due to lower capacity utilization and higher fixed costs per ton of shipments. It is likely that steel firms would attempt to recover these higher costs through price increases without which net income would decline below the target rate of return on common equity. If shipments fell below the long-run trend by 10 percent, price adjustments would result in increases of approximately $6 or 1.6 percent per ton in the long run.

If shipments were to exceed the long-run trend by 10 percent and capacity additions were planned to meet trend requirements, the steel industry would find itself in a position where it could decrease its price and continue to achieve the target rate of return. Facing capacity shortages, it is likely that firms within the steel industry would maintain price, increase internal sources by realizing a rate of return on common equity in excess of their target, and thereby reduce external financing needs.

This analysis, coupled with the earlier conclusion that the steel industry would have extreme difficulty in financing its expansion plans under the optimistic shipments forecast, would suggest that the steel industry might not undertake rapid expansion at this time.

SENSITIVITY ANALYSIS: ALTERNATIVE RATES OF RETURN ON EQUITY

In the previous section the economic impact of alternative rates of return on equity was analyzed in terms of revenue requirements and price effects. Equally important is the impact of profitability upon external financing needs. An increase in the rate of return on common equity, other things being equal, would increase net income, retained earnings and internal cash generation, and decrease external financing requirements. Furthermore, maintenance of a given capital structure would imply that this increase in retained earnings would result in a complementary decrease in common stock issued.[4]

If steel firms were able to achieve a rate of return on equity comparable with the average of all manufacturing firms, short-run retained earnings would increase from \$2.5 to \$3.3 billion with a net decrease in external financing needs from \$7.3 to \$6.5 billion. Thus while increased profitability would considerably enhance the ease with which the steel industry could obtain its external financing, it would not significantly reduce its financing needs.

Financing difficulties would be far more drastic than the baseline case if the inadequate profit levels on steel operations reported by the major integrated steel firms[5] continue rather than improve to the average of all steel company operations as assumed in the baseline case. Under these circumstances,

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[4] *It should be noted that the increase in net income results in increased revenues and, therefore, increased working capital requirements. This increase in working capital would be financed through a mix of debt and equity.*

[5] *Once again, it should be noted that the rate of return on steel operations alone is not publicly available from annual financial statements. Estimates of this rate of return have been provided by AISI.*

retained earnings in the short run would decline by nearly 40 percent from $2.5 to $1.5 billion. The corresponding increase in external financing needs would be from $7.3 to $8.2 billion. This 12 percent increase in external financing requirements certainly would exacerbate the short-run financing problem; however, the inability to earn an adequate return on common equity by itself would undermine the ability of steel firms to attract capital at acceptable rates.

SENSITIVITY ANALYSIS: HIGHER COST OF CAPITAL

Many industry observers fear that the external financing burden of the next decade will increase the cost of the steel industry's long-term debt, increase the yield to investors in its common stock, or both. In order to evaluate the effect of an increased cost of capital upon external financing requirements and average steel prices, TBS increased the interest rate on new issues of long-term debt and the target rate of return on common equity by 1 percent.

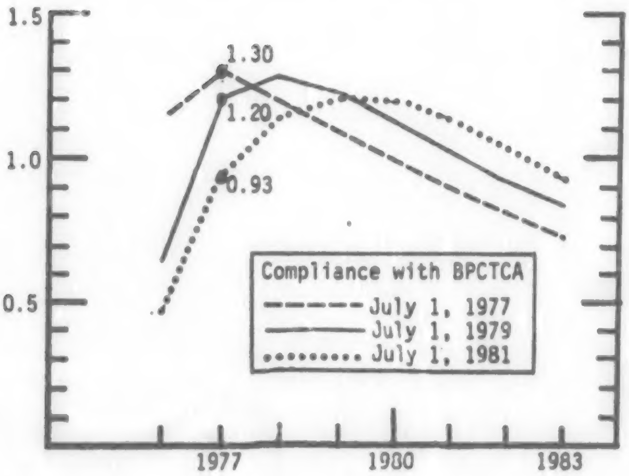
Under these conditions, total long-run external financing requirements decline from $17.5 to $16.8 billion--a decrease of 4 percent. This results from the increase in net income and retained earnings, an increase which results in a price increase of less than $3.50 or 1.0 percent. Thus a 1 percent increase in the cost of capital would result in an average price increase of less than 1 percent.

SENSITIVITY ANALYSIS: BPCTCA COMPLIANCE SCHEDULE

As described in an earlier section, the date by which full compliance with BPCTCA is obtained has a significant effect on the timing of capital expenditures. Alternative compliance dates affect not only the timing of external financing requirements, but also the amount required in any given time period.

Both of these impacts can be observed in the following chart:

CUMULATIVE EXTERNAL FINANCING OF
ALTERNATIVE BPCTCA COMPLIANCE DATES
(billions of 1975 dollars



Compliance by the 1977 statutory date for BPCTCA requires $1.3 billion in short-run external financing. This is an increase of $0.1 billion or 3 percent in the total over compliance by 1979, the date of compliance assumed elsewhere in this report. In addition, these financing requirements peak in 1977 and steadily decline thereafter as a result of the increased cash flow from related internal sources, primarily in the form of depreciation.

The short-run external financing needs associated with the 1979 compliance schedule assumed in this report are $1.2 billion. This delay in the BPCTCA compliance schedule appears to increase total financing needs as indicated by the 1975-1983 period. However, these streams of cumulative financing needs converge in the more distant future as the related water pollution control equipment becomes fully depreciated. Delay of the compliance schedule until 1981 decreases short-run financing requirements a total of $0.3 billion, or 7.2 percent, as compared to 1979 compliance as assumed elsewhere in this report.

8. OTHER IMPACTS OF ENVIRONMENTAL REGULATIONS

Environmental regulation in the steel industry will have other economic effects. The most significant of these other impacts will concern changes in the industry's consumption of energy and its levels of employment. Effects may also be expected in communities where significant amounts of steelmaking are concentrated and in the nation's balance of trade. This section discusses these impacts. Detailed findings regarding energy and employment impacts are presented in Appendix G.

ENERGY IMPACTS

The manufacture and finishing of iron, steel, and steel mill products requires extremely large amounts of energy. In recent years the steel industry has used approximately 20 percent of the total energy consumed within the manufacturing sector. At least half of this amount is consumed in the ironmaking stage of production, which includes both coke ovens and blast furnaces.

In calculating the energy requirements for the steel industry, TBS relied on estimates of fuel and electrical power consumption per ton of throughput for each process. These engineering estimates were provided by Arthur D. Little for the production processes and by EPA technical contractors for water and air pollution control equipment. Alternative estimates for water and air pollution control were also provided by ADL. With the exception of metallurgical coal, these estimates do not include the energy content of the raw materials used in the steelmaking process. Thus, the energy consumed in mining and/or preparation of iron ore, limestone, steel scrap, oxygen, and fluxes and alloying materials is not included. In addition, non-process related consumption of energy is not included.

Because of its magnitude, the energy content of metallurgical coal used as input to the coke ovens was included in these calculations. Additionally, the energy estimates include the energy generated in the forms of blast furnace and coke oven gas, which is typically used in downstream processes. The production of these gases results in a net energy credit being assigned to these two processes.

A summary of energy requirements is as follows:

ENERGY REQUIREMENTS
(quadrillion Btu)

	Short Run 1975-1977	Long Run 1975-1983
Baseline	6.71	22.95
Pollution Control Equipment		
Water	0.03	0.33
Air	0.01	0.11
TOTAL	0.04	0.44
GRAND TOTAL	6.75	23.39
Pollution Control as a Percent of Baseline	0.06%	1.9%

Exhibits 30 and 31 detail these energy requirements by time period, and by stage of production and environmental regulation, respectively.

The energy impact of environmental regulations is minor when compared to the large energy requirements for steel production. Pollution control equipment placed into service during the 1975-1983 period will increase energy consumption by 0.4 quadrillion Btu, approximately 2 percent of the baseline levels.

When the energy consumption of pollution control facilities already in place is included, total energy use associated with environmental regulations is calculated to be 0.8 quadrillion Btu, or less than 4 percent of the industry total.[1] Water pollution equipment is responsible for more than 60 percent of total pollution control energy consumption with air pollution equipment responsible for the remainder.

The energy requirements to operate all pollution control facilities within the steel industry will be approximately 135 million barrels of residual fuel oil or equivalent during the 1975 to 1983 period. These requirements amount to 41,000 barrels per day.

Projections of requirements utilizing NUS/Cyrus Rice and Arthur D. Little estimates of energy use associated with water pollution control equipment are comparable--0.5 quadrillion Btu, including equipment placed into service prior to 1975. However, the ADL estimate of energy requirement for air pollution abatement is twice that based upon the energy use assumed by Battelle Columbus Laboratories and EPA-Durham. This significant difference follows from the air flow assumptions employed by EPA-Durham in its assessment of fugitive emission requirements.

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[1] *Other studies have relied upon different assumptions to calculate estimates of energy for pollution control. These estimates range from 4 to 9 percent of total steel industry requirements.*

EMPLOYMENT EFFECTS

The construction, installation, and operation of pollution control facilities will create additional jobs. Total employment from the operation of these facilities is summarized below:

SUMMARY OF STEEL INDUSTRY EMPLOYMENT[a]
(thousands of jobs)

	Short Run 1977	Long Run 1983
Baseline Conditions	444.6	444.5
Water Pollution Control	1.4	9.0
Air Pollution Control	.4	3.6
TOTAL EMPLOYMENT	446.4	457.1

[a] *Includes process-related direct and indirect employees only.*

Exhibits 32 and 33 detail these employment effects by time period, and by stage of production and environmental regulation, respectively. The decline in baseline employment is the result of increasing domestic shipments being more than offset by the underlying assumption that productivity will continue to improve at its historical rate of 2.3 percent per year.[2]

It is anticipated that 1,800 steel industry jobs will be required by 1977 to operate the additional pollution control equipment placed into service in or after 1975. These new jobs represent less than 1 percent of the industry's total employment and are in addition to the 2,400 jobs linked to the operation of pollution control equipment placed into

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[2] *This improvement in productivity alone would be responsible for the loss of more than 31,000 jobs in the short run and more than 88,000 jobs by 1983 if production requirements did not increase.*

service prior to 1975. By 1983, compliance with all environmental regulations will have created 12,500 additional jobs--a 3 percent increase over baseline employment. In total, more than 14,900 jobs will be required by 1983 to operate pollution control equipment within the steel industry.

In addition to jobs created directly within the steel industry, employment will also be created in the manufacture and installation of pollution control equipment. Utilizing the national average of 20 jobs per million dollars of annual production of pollution control equipment, the previously cited long-run capital expenditures of $6.8 billion will generate an annual average of 15,000 jobs in pollution control equipment-related industries. This employment will, in turn, create additional employment in unrelated industries.

Some reduction in production labor may offset these employment increases. Jobs could be lost if the higher prices due to the cost of pollution control result in a decline in domestic steel shipments. Jobs could also be lost if specific mills or plants were shut down. However, shutting down one operation might require expanding production at another plant. In that case, the net effect of either of these conditions would be a decline in employment only to the extent that production is shifted from more labor-intensive operations to less labor-intensive ones, or domestic production is replaced by imports and/or substitute materials.

COMMUNITY EFFECTS

The effect on communities of compliance with the proposed environmental regulations will vary by geographic region. Where plants are large and where significant amounts of steelmaking capacity are concentrated (e.g., in Pennsylvania, with over 20 percent of steelmaking capacity), closing of processes at one plant may result in additional jobs at another plant nearby.

Steel facilities in all but EPA Regions III and V are scattered, frequently small, and specialized. Production lost from closures in other regions may not be made up nearby. It will be replaced, possibly by very distant and unrelated plants. Therefore, closures in these areas will more likely result in loss of jobs to a community than would be true in EPA Regions III and V. However, should implementation of environmental regulations result in closures, some communities where the resulting lost production is supplemented will experience growth.

A direct assessment of potential community effects requires a detailed analysis of facilities which are marginally profitable and are likely to curtail operations when confronted with the necessity of installing pollution controls. Such specialized micro-economic analysis requires plant-specific data which are not generally available. Consequently, the EPA has been unable to conduct detailed economic studies of all such marginal facilities.

EPA has conducted an in-depth analysis of the potential economic effects of pollution control costs on the eight steel plants in the Mahoning Valley region of eastern Ohio.[3] The study was prompted by the knowledge that (1) the regional economy depends heavily upon steel production, and (2) these steel operations are among the most marginal in the country as a result of a variety of economic factors.

The EPA study found that the imposition of pollution controls (or any other major increase in production costs) is likely to degrade substantially the profitability of these plants. In these situations, there is considerable risk that the steel firms might elect to curtail operations rather than make the investments in pollution control necessary to meet environmental regulations.

On the basis of the findings from the Mahoning Valley study, EPA decided to provide substantial relief from the industry-wide effluent guidelines. This relief for the plants in the Mahoning Valley delays and possibly reduces the major investment required for effluent controls.

BALANCE OF TRADE EFFECTS

Since the mid-1950s, there has been a steady and rapid growth in imports of steel into the United States. Domestic steel companies have met this competition through improved service, specialized production and transportation benefits, as well as some price cutting--all of which have decreased profitability. In 1974 steel imports resulted in an unfavorable balance of trade of $3.0 billion, the greatest deficit of the decade.

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[3] *Economic Impact of Pollution Control Regulations on Steel Plants in the Mahoning River Valley*, *Booz, Allen, and Hamilton, Inc., March 1976.*

Compliance with the pollution control regulations will result in price increases on the order of $7 per ton in 1977 and $17 per ton in 1983. Thus competitive pressure may increase. However, as mentioned previously, the steel customer will face increases in nominal steel prices only slightly in excess of the rate of inflation in the overall economy.

A second mitigating factor is that worldwide demand approached worldwide capacity prior to the recent worldwide recession. At the same time foreign producers are experiencing an escalation in operating costs due to increased labor rates and raw materials prices. Foreign steel companies may voluntarily reduce exports to the United States in order to serve closer markets which would increase profitability through reduced absorption of transportation costs.

It is also expected that foreign producers will face pollution abatement requirements in the near future. Thus, the relative impact of public policy toward environmental issues within the United States and in foreign countries may play a dominant role in determining our balance of trade.

The net effect of these events on our balance of trade is unclear. Net imports of steel is the most difficult measure of demand to forecast since it is directly affected not only by domestic economic developments but by foreign ones as well. In addition, foreign steel has been an instrument of government policy in the past.

Under baseline conditions, net imports are expected to reach 16.7 million tons in 1980 and 18.9 million tons in 1985. In the short and long run, net imports are expected to fall within 12 percent of these tonnages should total demand fluctuate 10 percent above or below the baseline.

SECONDARY EFFECTS

Retail consumers, of course, do not purchase much steel directly. Ultimately, however, they must bear the cost of pollution control in the form of increased prices for the goods and services which they purchase. For example, an average motor vehicle requires 1.15 tons of steel.[4] Compliance with pollution control regulations is expected to increase the average price of steel by $16.75 per ton over the baseline. Thus pollution control abatement in the steel industry could require an increase in the cost of automobiles of $19.26. The automobile price increase might be larger if manufacturers add a profit margin to this cost increase. However, this effect may be mitigated through trends toward smaller cars and use of other materials in place of steel.

Although physical units are most difficult to assign in the construction industry, an estimate of the percent increase in total cost is possible. During 1975, 8.8 million tons[5] of steel were used by the construction industry. With the most conservative assumption that all this steel was utilized for the $46.9 billion[3] of non-residential private construction, the increase in total construction reqired to cover $16.75 per ton for pollution control costs would be 0.3 percent.

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[4] *"The report by the Federal Task Force on Motor Vehicle Goals beyond 1980," Volume 2, Dr. Bruce Rubinger.*

[5] *Annual Statistical Report 1975, AISI, page 32.*

[6] *Economic Report of the President, 1976, page 212.*

9. METHODOLOGY OVERVIEW

This section briefly reviews the methodology TBS used to determine the economic impact of environmental regulations on the U.S. steel industry. As discussed in earlier sections, the general approach involves the overlaying of future expenditures for pollution control on a baseline financial projection for the industry. Five broad measures are used to determine the economic impact of pollution control: (1) new capital expenditures; (2) increases in operating costs; (3) increases in revenue requirements; (4) changes in prices; and (5) effect on external financing needs. This basic approach was repeated a number of times to test the sensitivity of results to different estimates of future costs and operating parameters. Because of the complexity of the economic system under study, and the need to test a large number of cases, a computer model was developed to speed the computational process.

The computational methodology is discussed in greater depth in the following six parts of this section:

- Description of computer model developed to perform computations.
- Definition of the steel industry and coverage of the analysis.
- Determination of capital and operating cost projections for production operations--i.e., excluding expenditures for pollution control.
- Estimation of pollution control expenditures.
- Analysis of future revenue requirements and price levels.
- Computation of external financing needs.

Detailed information on each of the above methodological steps, from which it is possible to reconstruct or verify TBS's computations, is contained in Volume II of this report. In addition, the detailed methodology for some minor calculations done outside PTm(Steel), such as those required to determine secondary effects, is explained in the text where the findings appear.

COMPUTER MODEL

A computer model, called PTm(Steel), was developed by TBS to perform the large number of computations discussed in the last four parts of this section. The items below briefly describe the rationale for developing the model, the general types of information provided by the model, general approach followed, and finally, the overall structure of the model.

RATIONALE FOR MODEL DEVELOPMENT

A computer model greatly eases the task of analyzing numerous alternatives in a complex economic system. Although the necessary projections could be accomplished manually, a model provides speed, flexibility, and a consistent analytic approach. For example, a model enables an analyst to:

1. Determine the effect of different pollution control costs. The model provides a capability for testing the economic impact of a wide range of pollution control expenditures.

2. Examine the effect of several different economic conditions upon results. Because forecasts of future events cannot be certain, the outcome under alternative conditions should be analyzed. This analysis determines whether changes in specific economic conditions would have a major impact on

the ability of the steel industry to meet environmental regulations.

3. Explore the effect of different timing of capital expenditures. This factor is overlooked frequently in cost studies. Many studies use a capital recovery factor to approximate the average annual effect of a capital investment. This ignores the expenditures for construction prior to completion and the funds needed for such construction. A financial model readily accounts for these flows and allows testing of assumptions regarding construction lead times.

4. Provide a framework for considering different assumptions about industry structure or costs of pollution control equipment. This factor is perhaps the most compelling. Many studies have been performed on the cost of environmental regulations on the steel industry. Unfortunately, these studies are generally based upon different assumptions about industry structure or economic conditions. Thus, it is important that the policy maker have a capability for evaluating these estimates on a common basis.

INFORMATION PROVIDED BY THE MODEL

The model, PTm(Steel), develops projections of the future financial position of the steel industry. It summarizes the economic information in traditional financial reports--i.e., income statements, sources and uses of funds, and balance sheets. These pro-forma financial statements can be analyzed by conventional means. The model also produces a number of supporting reports, such as production reports for each major class of steel product.

APPROACH USED IN THE MODEL

The model computes steel industry financial forecasts based on projections of steel shipments, operating costs, and financial factors. A key element of the model is a bottom-up approach for computing future revenues. In the model, revenues are those amounts required to cover projected operating costs plus provide a specified rate of return on stockholder equity.

Many factors which affect the results of the analysis are determined outside of PTm(Steel). For example, the demand for steel is determined by general economic conditions and other factors. Another important factor determined outside the model is the maximum long-term utilization rate of plant capacity. Technological changes, such as the replacement of conventional forming with continuous casting, are also determined outside PTm(Steel). The financial effects of these factors are, however, computed by PTm(Steel).

OVERALL STRUCTURE OF THE MODEL

PTm(Steel) consists of three main logical components labeled "Production and Capacity Requirements," "Environmental Costs," and "Financial Results." Each of these components in turn consists of subcomponents. The relationships among the three components are shown in Exhibit 34 and discussed briefly below:

1. Production and capacity requirements in future years are determined from projections of future demand for steel products. These quantities are then used to determine the

quantities of production inputs. A cost is computed for each production input and passed on to the financial component.

2. The environmental cost component computes operations and maintenance costs and capital expenditures required for environmental control. It combines engineering estimates of pollution control costs with production and capacity forecasts derived in the model's first component.

3. The financial results component combines the cost information received from the two other components with the capital structure of the industry to prepare pro-forma financial statements for the industry. Although projections within the financial analysis module of PTm(Steel) are made in current dollars, for reporting purposes these financial data are deflated to 1975 dollars using the Chase Econometrics GNP deflator. This step improves comparability between future periods and 1975 actual performance.

DEFINITION OF THE STEEL INDUSTRY AND COVERAGE OF THE ANALYSIS

The definition of the steel industry used in this study is similar to that used in the study by ADL for AISI. This definition includes on-site raw material preparation through all steel finishing mills. It excludes extraction of raw materials, transportation, and all uses of steel products such as construction and shipbuilding. Further, it excludes steel company operations in unrelated fields such as chemicals and cement manufacture. (Exhibit 4 contains a graphic description of this steel industry definition.) This definition was selected for two reasons. First, it coincides with the definition used by EPA in establishing effluent limitations guidelines for the point source category. Second, production and plant inventory data based on this definition are available for substantially all AISI members.

Although the TBS definition of the steel industry is consistent with that used by NUS/Cyrus Rice in establishing effluent limitations guidelines for EPA, the subcategorization differs. In order to make use of the ADL-AISI operating and cost data, TBS divided the steel manufacturing process into the same 28 subcategories used by ADL. However, NUS/Cyrus Rice specified 31 pollution control subcategories--each representing flows of similar effluent streams. A correspondence between these 31 subcategories and the 28 production processes used by TBS is shown in Exhibit 35.

It was not necessary to make a similar adaptation for air pollution control subcategories. The production processes correspond directly to the categories used for air pollution control.

The coverage of the analysis was limited by the availability of production and plant inventory data. The most complete industry data available result from the study for AISI by ADL. This analysis included 99 percent of AISI members which in turn account for 94 percent of steel shipments. Thus, the steel industry analysis of the study pertains to 93 percent of shipments, production, and capacity. The analysis could be expanded to cover 100 percent of the steel industry should more complete data become available.

CAPITAL EXPENDITURE AND COST PROJECTIONS FOR PRODUCTION OPERATIONS

Capital and operating cost projections are developed for each of the 28 different production processes which together represent the steelmaking industry. In each process, future production and capacity requirements are developed from projections of demand for different steel products. Capital and operating costs are then determined from future production and capacity requirements. The items below expand on this description.

STEEL SHIPMENT FORECASTS

Steel shipment forecasts are made outside the model using ten-year linear trend extrapolations. Because most observers agree that the demand for steel is relatively inelastic with respect to price, the effect of prices on future shipments was not reflected directly in the projections of shipments. Instead, TBS tested the sensitivity of financial results to optimistic and pessimistic projections of steel shipments, i.e., 10 percent above and 10 percent below the basic trend line. This range bounds most publicly-available projections of steel shipments. It also bounds the possible effect of price increases due to pollution control costs.

Aggregate steel shipments are separated into 12 product categories in order to determine production requirements. These product categories, shown in Exhibit 35, are the same as those in the ADL study. They were selected because they correspond to the plant inventory and production data utilized and can be derived directly from the AISI published product data, as is also shown in Exhibit 35. TBS has assumed that the product mix observed in 1972 will continue to shift as it has in the previous ten years. The result is a different product mix in each year. However, alternative mix assumptions, such as a static mix, can be evaluated.

PRODUCTION REQUIREMENTS

Production requirements are derived from forecasted shipments of each of the 12 classes of steel products and from technological relationships. The production requirement for each of the 28 processes in each year is determined with the assistance of a linear program which accounts for all flows (but does not optimize production). The constraints require that sufficient production occur in each process to meet the needs of subsequent processes and eventually of product shipments. Technology changes are simulated by varying the constraints over time.

Technology changes are presumed to occur in only a limited number of processes. Basic oxygen furnaces and electric arc furnaces replace open hearth furnaces; continuous casting replaces conventional casting and primary breaking. The shift to more modern steel making furnaces is accompanied by a greater proportion of vacuum degassing.

Many elements of industry structure in the model remain constant over time. Yields--the amount of production divided by the amount in input--of each process are a constant throughout the period of analysis. However, the overall yield from steelmaking to finished products does vary due to the technology shifts described above. Just as yields for each process are held constant, the material balances required in each process are also held constant.

CAPACITY REQUIREMENTS

Capacity requirements in each year are computed to meet production requirements at the planning utilization. The planning utilization is the maximum long-term sustainable rate of use. A production requirement of 99 million tons for a process with a planning utilization of 90 percent would, for example, require a capacity of 110 million tons (99 = 90% x 110). Alternative planning utilizations which would alter the projected capacity additions can be incorporated in PTm(Steel).

Capacity additions occur whenever requirements exceed existing capacity. PTm(Steel) was initialized with the capacity profile obtained from ADL, which represents 93 percent of U.S. domestic production in all. These plants were separated into three groups by size. Capacity additions are assumed to be in the form of the average existing large unit. These units achieve the highest economics of scale in capital and operating costs of the three categories. Costs for capacity addtions are reduced further by the assumption that new capacity is brought on-stream at the time it is needed, i.e, that there is no overcapacity such as might result from competitive actions by individual steel firms.

Retirements cannot be computed in as straight-forward a manner as additions. Data on retirements by process are not available for historic or future periods. In the absence of specific process retirement data, TBS has assumed that existing facilities will continue to be maintained and modernized to continue their productive life. For each process ADL, in its study for AISI, computed an annual factor which, when adjusted for inflation, would approximate the rework expenditure. These rework factors are used in this analysis to determine the costs required to maintain and modernize existing facilities

CAPITAL EXPENDITURE AND COST COMPUTATIONS

Capital expenditures and operating costs are derived from projections of capacity and production requirements in each of the 28 processes. Capacity and production forecasts are used to develop estimates of plant expansions and of production inputs such as fuel and labor. These production inputs, in turn, are costed out for future years using estimates developed by ADL. These steps are carried out in the production and capacity component of the PTm(Steel) model. The production inputs and unit costs are passed on to the financial component where they are multiplied together to arrive at projections of capital and operating costs.

ENVIRONMENTAL COSTS

This step overlays estimates of pollution control costs on the costs of producing steel. Differences in the format of pollution control engineering cost estimates require that air and water pollution control costs be determined by separate subcomponents. In addition, "other," typically non-process-specific pollution control costs, are also computed separately. Each of these three subcomponents is described below.

WATER POLLUTION CONTROL COSTS

The water pollution control subcomponent is designed to accept a variety of engineering cost estimates. This study is, however, based upon the engineering cost estimates contained in the previously cited Effluent Limitations Guidelines Development Documents for Phases I and II. In addition to the estimates developed by EPA, estimates developed for the AISI were included.

The proportion of capacity which has pollution control equipment installed in the first year of the analysis varies by process. This proportion is increased for each process so that all processes are fully controlled by a specified date. Additional capacity is assumed to meet BPCTCA requirements if construction was begun prior to the proposal of the NSPS regulations.

Capital expenditures for water pollution control equipment are assumed to offer economies of scale. Capital expenditures for water pollution control are determined for each of the three sizes of units for each process treated. Operations and maintenance expenses are then determined in accordance with the engineering cost estimates. Since some cost elements, such as maintenance, are determined from the cost of installed pollution control equipment, they also exhibit economies of scale. Others, such as electric power, are determined from the production volume and do not exhibit economies of scale.

Engineering cost estimates in the Development Documents do not include cost reductions possible through commingling of waste streams from different processes. ADL developed estimates of potential effects from commingling in its report for AISI. TBS has applied the ADL factors to engineering cost estimates developed for EPA as a measure of the sensitivity of the findings to this opportunity for savings.

AIR POLLUTION CONTROL COSTS

The air pollution control subcomponent, like its water counterpart, is designed to accept a variety of engineering cost estimates. This study is based on cost estimates from the "1974 Cost of Clean Air" report for stack emissions and from EPA analysis for fugitive emissions. As in the case of water pollution control, it is assumed that there are economies of scale in the control of air pollution.

Unlike water pollution control subcategories, there is a direct correspondence between production processes and air pollution control subcategories. There are, however, three types of treatment equipment--electrostatic precipitators, venturi scrubbers, and fabric filters--which may be used on each production process to control stack emissions. Different types of equipment may be selected for the same process at different facilities. Thus, there is a mix of equipment types for each process. This mix and the amount of existing treatment were obtained from the "1974 Cost of Clean Air." The mix of equipment types achieved at full compliance was obtained from the Strategic Environmental Assessment System of EPA.

The proportion of capacity treated in each year is determined by increasing compliance in equal yearly increments until full compliance is achieved. The amount of production and capacity treated for stack or fugitive emissions for each process is determined from this proportion and from the total amount of capacity and production.

OTHER POLLUTION CONTROL COSTS

Other pollution control costs are those costs associated with the steel industry, but not with particular processes. For example, storm run-off and on-site electric power generation are included in other pollution control costs.

The varied nature of categories included in other pollution control costs necessitates computation outside PTm(Steel). Costs for each category are computed in accordance with the engineering cost parameters and the schedule of compliance. The resulting costs for each year are passed from the environmental cost component to the financial component.

REVENUE REQUIREMENTS AND PRICE LEVELS

The financial analysis component of PTm(Steel) calculates future revenues required by the industry to cover costs of production operations, to meet required pollution control expenditures,[1] and to provide a targeted return on equity. Future price levels to provide these revenues are computed simply by dividing total projected revenue by forecasts of domestic steel shipments.

This approach is useful for analysis of the revenue and price impacts of increased costs and capital expenditures. It is particularly useful over the long term when prices and revenues will reflect attempts to realize a targeted average return on equity. In other words, over the long term we would expect revenues to be high enough to meet expenses and to provide the targeted return to the industry's stockholders.

The steps listed below are followed to derive revenue requirements in any future year.

1. Operation and maintenance costs for production and pollution control are computed from the amount of production by each process times each cost element(e.g., labor, power) and the corresponding current dollar cost.

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[1] *The financial analysis component also computes external funds requirements. This computation is discussed in the final part of this section.*

2. Depreciation is computed from the gross plant value using the straight-line method.

3. Interest charges are calculated from specified interest rates and the projected amount of long-term debt outstanding.

4. Profit after tax is determined by multiplying the target rate of return on equity by the amount of stockholders' equity.

5. Income taxes, both state and federal, are computed as a specified proportion of profit after tax.

6. Revenue requirements are computed as the sum of 1 through 5 above.

The results of these steps are summarized in a complete income statement for the steel industry.

EXTERNAL FINANCING NEEDS

External financing needs are derived in the model by computing the difference between total funds requirements in each year of analysis and the amount of funds generated internally. If the requirements are greater than the internal sources, long-term debt and equity are issued to meet the deficit in amounts that maintain the specified debt-to-equity ratio for the industry. If total internal sources are greater than the fund requirements in a given year, the excess funds are invested in short-term notes which bear an interest rate 1 percentage point below the long-term interest rate for that year. These excess funds then become available as a source of funds in the next year, and the interest earned on them during the year is counted as extra revenue in the calculation of the income statement.

FUNDS REQUIREMENTS

The model accounts for three basic uses of funds by the steel industry.

1. Capital spending. This first use of funds includes capital expenditures for new plant put into service and construction work in progress for both production and pollution control equipment. In addition, capital expenditures include amounts for reworks and modernization of facilities.

2. Changes in working capital. The total amount of working capital required in each year is calculated by the model as a percentage of the previous year's revenues. The percentage used, which is held constant for all years of the analysis, is the average of the actual percentages for 1970-1974, based on figures in the AISI "Annual Statistical Report." The previous year's working capital amount is subtracted from the current year's amount to yield the change in working capital. An increase in working capital is a use of funds, while a decrease is a source of funds due to the resulting partial liquidation of working capital.

3. Long-term debt refundings. Long-term debt outstanding at the beginning of the analysis is input to the model as an initial condition, and a percentage of this debt is refunded in each year. The specific percentage used is the average of actual refundings for the past decade as reported by the American Iron and Steel Institute.

INTERNAL SOURCES OF FUNDS

Two internal sources of funds are considered:

1. Retained earnings are calculated from the required net income in each year and a dividend payout ratio. For this analysis the dividend payout ratio was based on individual company data for the past decade, as reported in annual reports and Securities and Exchange Commission Form 10K's.

2. Depreciation charges are the same as those derived for the income statement and are used to compute revenue requirements. Depreciation charges are added to retained earnings to yield total internal sources.

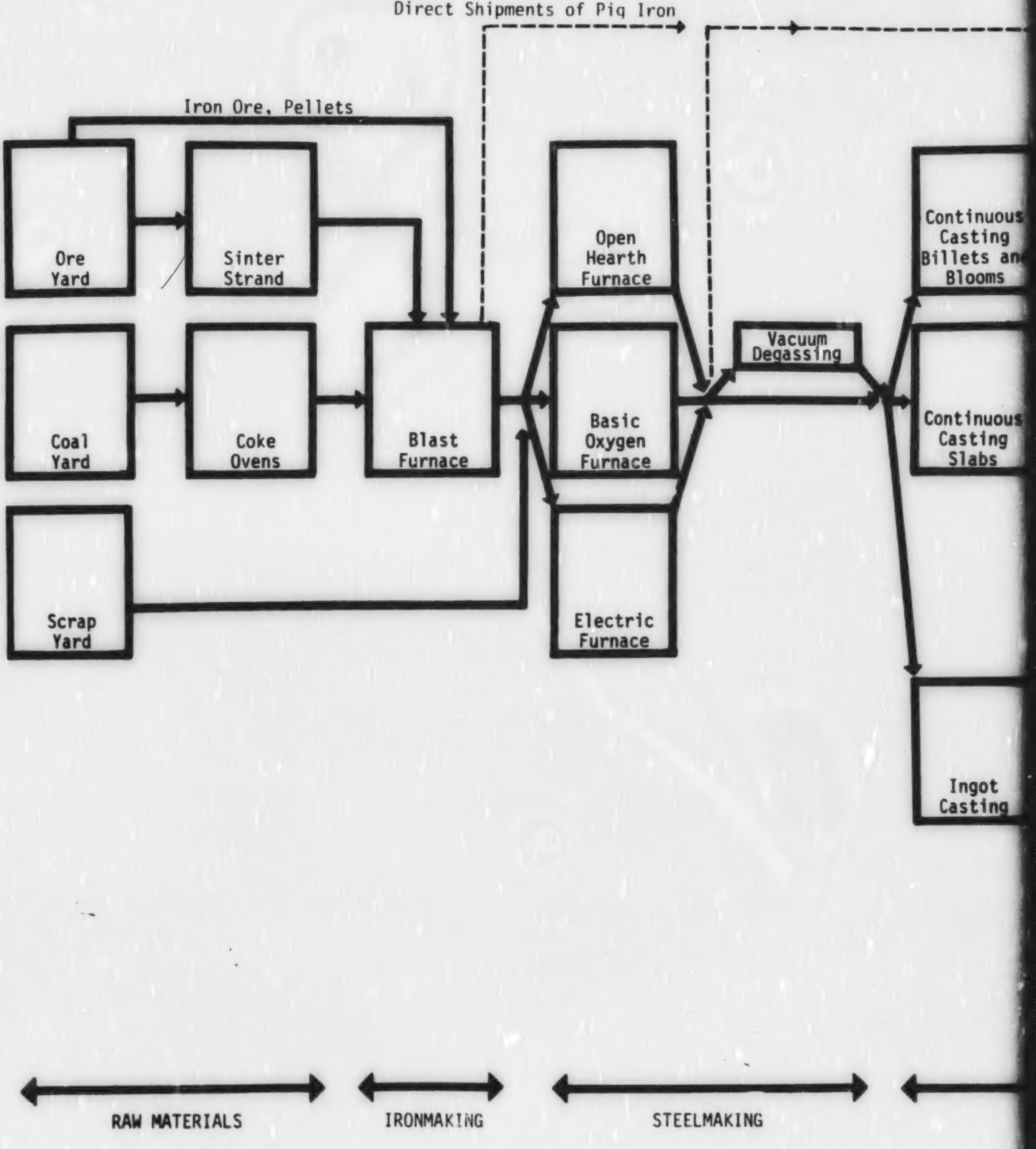
EXTERNAL SOURCES OF FUNDS

Issues of long-term debt and equity make up the external sources of funds in each year when they are required. All of the stockholders' equity within PTm(Steel) is assumed to be common equity, because of the raltively small and decreasing amount of preferred stock in the industry's capital structure in the past 15 years.

The new debt and equity are issued without limit. The model does not impose any constraints relating to availability of debt and equity funds in the marketplace. The relative amounts of debt and equity issued are calculated from a capitalization ratio input to PTm(Steel). This ratio expresses the amount of equity as a percent of total capitalization (long-term debt plus equity). The ratio used in this analysis was calculated from data in the AISI "Annual Statistical Reports" for the period 1965-1974.

Exhibit 4

SCHEMATIC OF STEEL PRODUCTION PR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Iron Ore, Pellets
Ore Yard
Sinter Strand
Coal Yard
Coke Ovens
Blast Furnace
Scrap Yard
Open Hearth Furnace
Basic Oxygen Furnace
Electric Furnace
Vacuum Degassing
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Continuous Casting Slabs
Ingot Casting
RAW MATERIALS
IRONMAKING
STEELMAKING

ON PROCESS

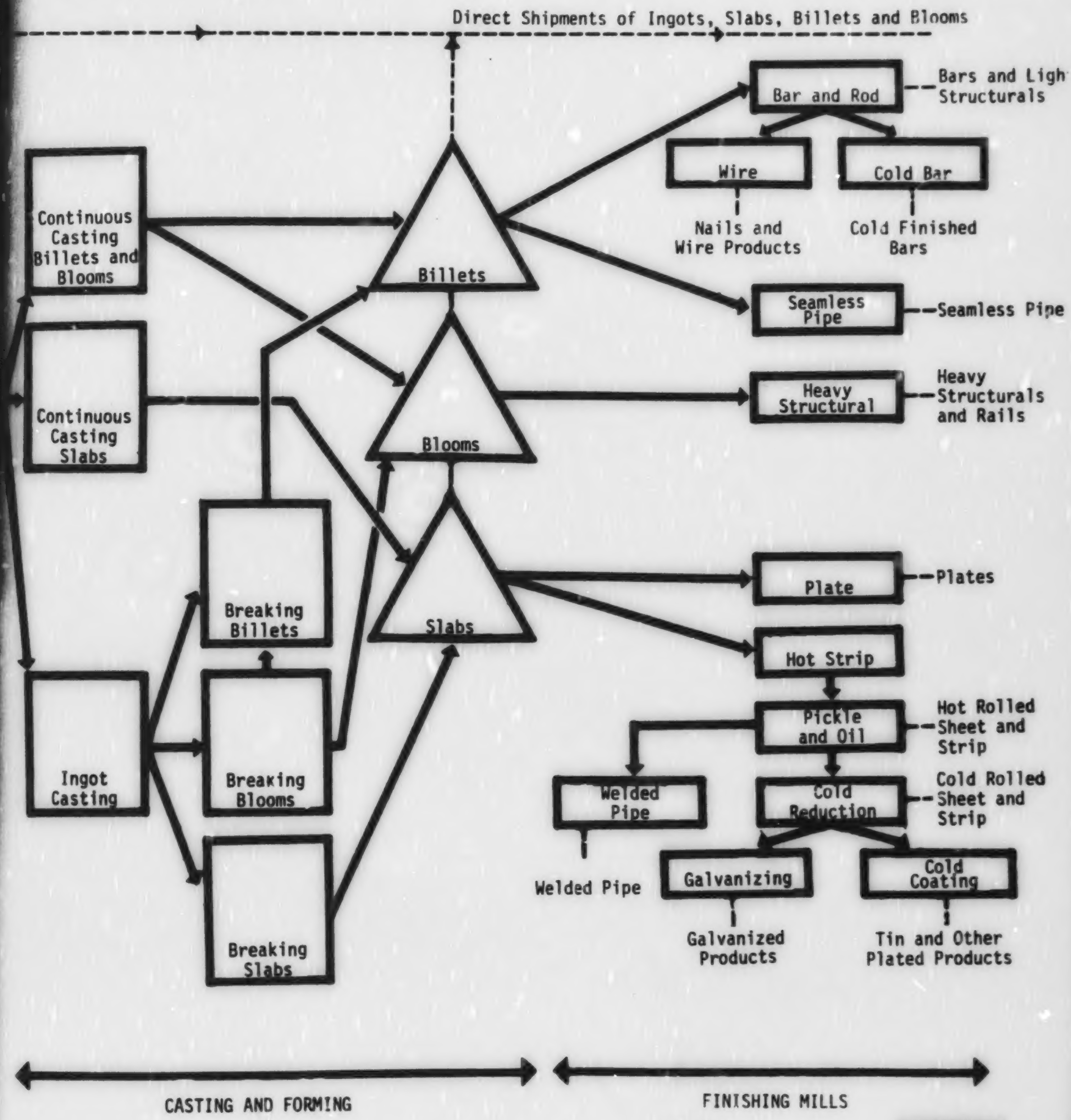

Direct Shipments of Ingots, Slabs, Billets and Blooms
Continuous Casting Billets and Blooms
Continuous Casting Slabs
Ingot Casting
Breaking Billets
Breaking Blooms
Breaking Slabs
Billets
Blooms
Slabs
Bar and Rod
Bars and Ligh
Structurals
Wire
Cold Bar
Nails and Wire Products
Cold Finished Bars
Seamless Pipe
Seamless Pipe
Heavy Structural
Heavy Structurals and Rails
Plate
Plates
Hot Strip
Pickle and Oil
Hot Rolled Sheet and Strip
Welded Pipe
Cold Reduction
Cold Rolled Sheet and Strip
Welded Pipe
Galvanizing
Cold Coating
Galvanized Products
Tin and Other Plated Products
CASTING AND FORMING
FINISHING MILLS

EXHIBIT 1

DOMESTIC STEEL SHIPMENTS 1960-1987

(MILLIONS OF TONS)

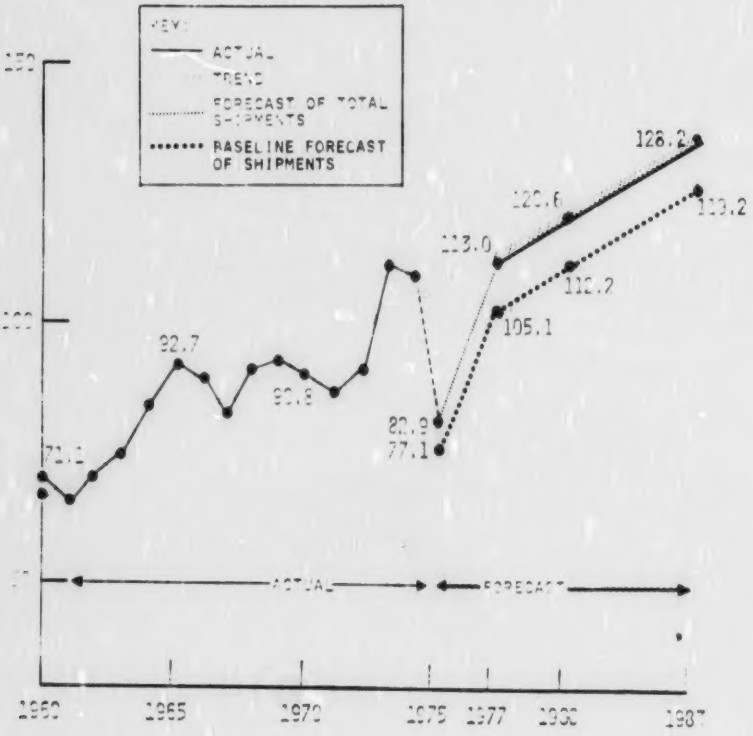


Exhibit 2

CAPITAL EXPENDITURES FOR CAPACITY EXPANSION BY TIME PERIOD
1975-1983
(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	$0.34	$0.66	$0.64	$1.64
Ironmaking	-	0.28	0.36	0.65
Steelmaking	0.55	0.51	0.47	1.53
Casting and Forming	0.35	0.68	0.96	1.99
Finishing Mills	2.09	0.78	0.94	3.80
Subtotal	$3.33	$2.90	$3.38	$9.61
Changes in Construction Work in Progress	0.40	0.61	0.99	2.01
Total	$3.73	$3.51	$4.37	$11.62

Source: PTm (Steel) projections

Exhibit 3

CAPITAL EXPENDITURES FOR REWORKS AND MODERNIZATION BY TIME PERIOD

1975-1933

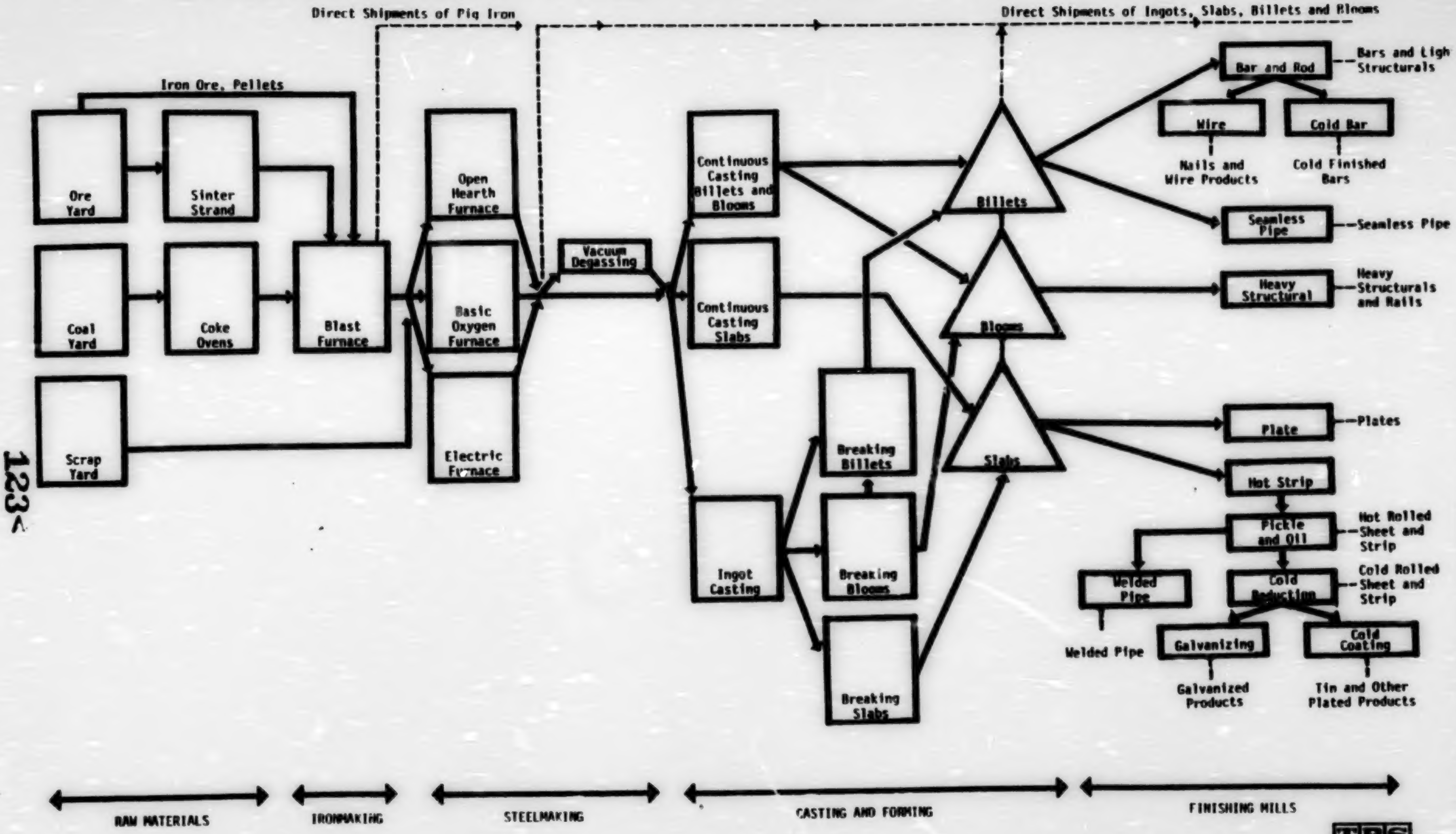
(billions of 1975 dollars)

Process Equipment Placed into Service	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation	$0.47	$0.52	$0.58	$1.58
Ironmaking	0.52	0.53	0.56	1.61
Steelmaking	0.15	0.17	0.19	0.51
Casting and Forming	1.05	1.08	1.11	3.24
Finishing Mills	2.80	3.03	3.13	8.95
Total	$4.99	$5.34	$5.56	$15.89

Source: PTm (Steel) projections

Exhibit 4

SCHEMATIC OF STEEL PRODUCTION PROCESS


Direct Shipments of Pig Iron
Direct Shipments of Ingots, Slabs, Billets and Blooms
Iron Ore, Pellets
Ore Yard
Sinter Strand
Coal Yard
Coke Ovens
Scrap Yard
Blast Furnace
Open Hearth Furnace
Basic Oxygen Furnace
Electric Furnace
Vacuum Degassing
Continuous Casting Billets and Blooms
Continuous Casting Slabs
Ingot Casting
Breaking Billets
Breaking Blooms
Breaking Slabs
Billets
Blooms
Slabs
Bar and Rod
Bars and Ligh Structurals
Wire
Nails and Wire Products
Cold Bar
Cold Finished Bars
Seamless Pipe
Seamless Pipe
Heavy Structural
Heavy Structurals and Rails
Plate
Plates
Hot Strip
Pickle and Oil
Hot Rolled Sheet and Strip
Welded Pipe
Welded Pipe
Cold Reduction
Cold Rolled Sheet and Strip
Galvanizing
Galvanized Products
Cold Coating
Tin and Other Plated Products
RAW MATERIALS
IRONMAKING
STEELMAKING
CASTING AND FORMING
FINISHING MILLS

TBS

Exhibit 5

OPERATIONS AND MAINTENANCE EXPENSES FOR IRON AND STEEL PRODUCTION BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$40.03	$51.56	$58.68	$150.27
Ironmaking	0.90	1.10	1.14	3.15
Steelmaking	13.78	16.19	16.63	46.60
Casting and Forming	5.06	6.55	7.25	18.86
Finishing Mills	17.50	21.17	22.37	61.03
Total	$77.27	$96.56	$106.07	$279.91

Source: PTm (Steel) projections

Exhibit 6

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT PLACED INTO SERVICE PRIOR TO 1975 BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.10	$0.12	$0.12	$0.34
Ironmaking	0.10	0.12	0.12	0.35
Steelmaking	0.06	0.06	0.07	0.19
Casting and Forming	0.03	0.03	0.03	0.09
Finishing Mills	0.39	0.46	0.48	1.32
Total	$0.68	$0.79	$0.82	$2.29

Source: PTm (Steel) projections

Exhibit 7

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT PLACED INTO SERVICE PRIOR TO 1975 BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.01	$0.02	$0.02	$0.05
Ironmaking	-	-	-	-
Steelmaking	0.20	0.21	0.20	0.62
Casting and Forming	-	-	-	-
Finishing Mills	-	-	-	-
Total	$0.22	$0.23	$0.22	$0.67

Source: PTm (Steel) projections

Exhibit 8

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

NUS/Cyrus Rice Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	$0.01	$0.03	$0.06	$0.10
Ironmaking	0.04	0.05	0.04	0.13
Steelmaking	0.06	0.04	0.06	0.15
Casting and Forming	0.11	0.14	0.12	0.37
Finishing Mills	0.59	0.69	0.45	1.74
Subtotal	$0.81	$0.95	$0.73	$2.49
Changes in Construction Work in Progress	0.77	(0.14)	(0.29)	0.34
Total	$1.58	$0.81	$0.44	$2.83
Storm Runoff[1]	0.02	0.08	0.05	0.15
Other Water[1]	0.16	0.29	0.15	0.60
Grand Total	$1.76	$1.17	$0.64	$3.57

[1] Includes changes in construction work in progress

Source: PTm (Steel) projections

Exhibit 9

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY EFFLUENT GUIDELINE

NUS/Cyrus Rice Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Process Equipment Placed Into Service				
Raw Materials Preparation	$0.01	$0.07	$0.01	$0.10
Ironmaking	0.08	0.04	0.02	0.13
Steelmaking	0.03	0.06	0.06	0.15
Casting and Forming	0.15	0.07	0.15	0.37
Finishing Mills	1.12	0.57	0.04	1.74
Subtotal	$1.39	$0.81	$0.28	$2.49
Changes in Construction Work in Progress	0.15	0.06	0.13	0.34
Total	$1.54	$0.87	$0.41	$2.83
Storm Runoff[1]				0.15
Other Water[1]				0.60
Grand Total				$3.57

[1] Includes changes in construction work in progress

Source: PTm (Steel) projections

Exhibit 10

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

NUS/Cyrus Rice Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.11	$0.16	$0.23	$0.50
Ironmaking	0.11	0.15	0.21	0.47
Steelmaking	0.08	0.11	0.14	0.32
Casting and Forming	0.04	0.09	0.11	0.24
Finishing Mills	0.50	0.84	1.01	2.35
Subtotal	$0.84	$1.35	$1.70	$3.88
Storm Runoff	*	0.02	0.09	0.10
Other Water	0.03	0.18	0.63	0.85
Grand Total	$0.86	$1.55	$2.42	$4.83

*less than $5 million

Source: PTm (Steel) projections

Exhibit 11

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY EFFLUENT GUIDELINE

NUS/Cyrus Rice Engineering Cost Estimates
1975-1983
(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Process Equipment				
Raw Materials Preparation	$0.37	$0.10	$0.03	$0.50
Ironmaking	0.37	0.09	0.01	0.47
Steelmaking	0.20	0.06	0.06	0.32
Casting and Forming	0.17	0.02	0.05	0.24
Finishing Mills	2.20	0.14	0.01	2.35
Subtotal	$3.31	$0.41	$0.16	$3.88
Storm Runoff				0.10
Other Water				0.85
Grand Total				$4.83

Source: PTm (Steel) projections

Exhibit 12

COMPARISON OF CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT

NUS/Cyrus Rice vs. Arthur D. Little Engineering Cost Estimates

In Place 1974 vs. Additions 1975-1983

(billions of 1975 dollars)

	NUS/Cyrus Rice Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	In Place 1974	Additions 1975-1983	Total	In Place 1974	Additions 1975-1983	Total
Process Equipment Placed into Service						
Raw Materials Preparation	$0.50	$0.10	$0.59	$0.33	$0.80	$1.13
Ironmaking	0.28	0.13	0.42	0.39	0.61	1.00
Steelmaking	0.17	0.15	0.32	0.15	0.17	0.32
Casting and Forming	0.13	0.37	0.50	0.09	0.35	0.43
Finishing Mills	0.42	1.74	2.15	0.43	1.45	1.88
Subtotal[1]	$1.50	$2.49	$3.99	$1.39	$3.38	$4.76

[1] Process equipment only

Source: PTm (Steel) projections

Exhibit 13

COMPARISON OF OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

NUS/Cyrus Rice vs. Arthur D. Little Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	NUS/Cyrus Rice Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	Equipment In Place	Equipment Additions	Total 1975-1983	Equipment In Place	Equipment Additions	Total 1975-1983
Process Equipment						
Raw Materials Preparation	$0.34	$0.16	$0.50	$0.59	$0.49	$1.09
Ironmaking	0.35	0.12	0.47	0.36	0.87	1.24
Steelmaking	0.19	0.13	0.32	0.14	0.08	0.22
Casting and Forming	0.09	0.15	0.24	0.08	0.22	0.30
Finishing Mills	1.32	1.03	2.35	0.34	1.04	1.37
Subtotal[1]	$2.29	$1.59	$3.88	$1.51	$2.70	$4.22

[1] Process equipment only

Source: PTm (Steel) projections

Exhibit 14

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

Environmental Protection Agency[1] Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	\$0.64	\$0.68	\$0.06	\$1.37
Ironmaking	-	0.36	0.01	0.37
Steelmaking	0.27	0.48	0.13	0.88
Casting and Forming	-	-	-	-
Finishing Mills	-	-	-	-
Subtotal	\$0.91	\$1.51	\$0.20	\$2.62
Changes in Construction Work in Progress	1.05	(0.69)	0.01	0.37
Total	\$1.96	\$0.82	\$0.22	\$2.99
Other Air[2]	0.13	0.08	0.04	0.26
Grand Total	\$2.09	\$0.90	\$0.26	\$3.25

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

[2] Includes changes in construction work in progress

Source: PTm (Steel) projections

Exhibit 15

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY EMISSION STANDARD

Environmental Protection Agency[1] Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Emission Standard		
	Stack	Fugitives	Total
Process Equipment Placed into Service			
Raw Materials Preparation	$0.93	$0.44	$1.37
Ironmaking	-	0.37	0.37
Steelmaking	0.49	0.39	0.88
Casting and Forming	-	-	-
Finishing Mills	-	-	-
Subtotal	$1.42	$1.20	$2.62
Changes in Construction Work in Progress	0.23	0.14	0.37
Total	$1.65	$1.34	$2.99
Other Air[2]			0.26
Grand Total			$3.25

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

[2] Includes changes in construction work in progress

Source: PTm (Steel) projections

Exhibit 15

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

Environmental Protection Agency[1] Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1975-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.19	$0.59	$0.70	$1.48
Ironmaking	-	0.12	0.20	0.32
Steelmaking	0.21	0.35	0.42	0.98
Casting and Forming	-	-	-	-
Finishing Mills	-	-	-	-
Subtotal	$0.40	$1.06	$1.32	$2.78
Other Air	0.02	0.07	0.13	0.22
Grand Total	$0.43	$1.13	$1.45	$3.01

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit 17

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY EMISSION STANDARD

Environmental Protection Agency[1] Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Emission Standard		
	Stack	Fugitives	Total
Process Equipment			
Raw Materials Preparation	$0.99	$0.50	$1.48
Ironmaking	-	0.32	0.32
Steelmaking	0.65	0.33	0.98
Casting and Forming	-	-	-
Finishing Mills	-	-	-
Subtotal	$1.63	$1.15	$2.78
Other Air			0.22
Grand Total			$3.01

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit 18

COMPARISON OF CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT

Environmental Protection Agency[1] vs. Arthur D. Little Engineering Cost Estimates

In Place 1974 vs. Additions 1975-1983

(billions of 1975 dollars)

	Environmental Protection Agency Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	In Place 1974	Additions 1975-1983	Total	In Place 1974	Additions 1975-1983	Total
Process Equipment Placed into Service						
Raw Materials Preparation	*	$1.37	$1.37	$0.11	$1.48	$1.58
Ironmaking	-	0.37	0.37	-	0.82	0.82
Steelmaking	0.68	0.88	1.56	0.66	3.50	4.16
Casting and Forming	-	-	-	-	0.09	0.09
Finishing Mills	-	-	-	-	0.01	0.01
Subtotal[2]	$0.68	$2.62	$3.30	$0.77	$5.90	$6.66

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

[2] Process equipment only

*Less than $5 million

Source: PTm (S [illegible] ojections

Exhibit 19

COMPARISON OF OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

Environmental Protection Agency[1] vs. Arthur D. Little Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Environmental Protection Agency Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	Equipment In Place	Equipment Additions	Total 1975-1983	Equipment In Place	Equipment Additions	Total 1975-1983
Process Equipment						
Raw Materials Preparation	$0.05	$1.43	$1.48	$0.07	$0.53	$0.60
Ironmaking	-	0.32	0.32	-	0.74	0.74
Steelmaking	0.62	0.36	0.98	0.80	2.83	3.64
Casting and Forming	-	-	-	-	0.07	0.07
Finishing Mills	-	-	-	-	*	*
Subtotal[2]	$0.67	$2.11	$2.78	$0.87	$4.19	$5.06

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

[2] Process equipment only

*Less than $5 million

Source: PTm (Steel) projections

Exhibit 20

SCHEMATIC OF TBS METHODOLOGY FOR ESTIMATING REVENUE REQUIREMENTS AND EXTERNAL FINANCING NEEDS

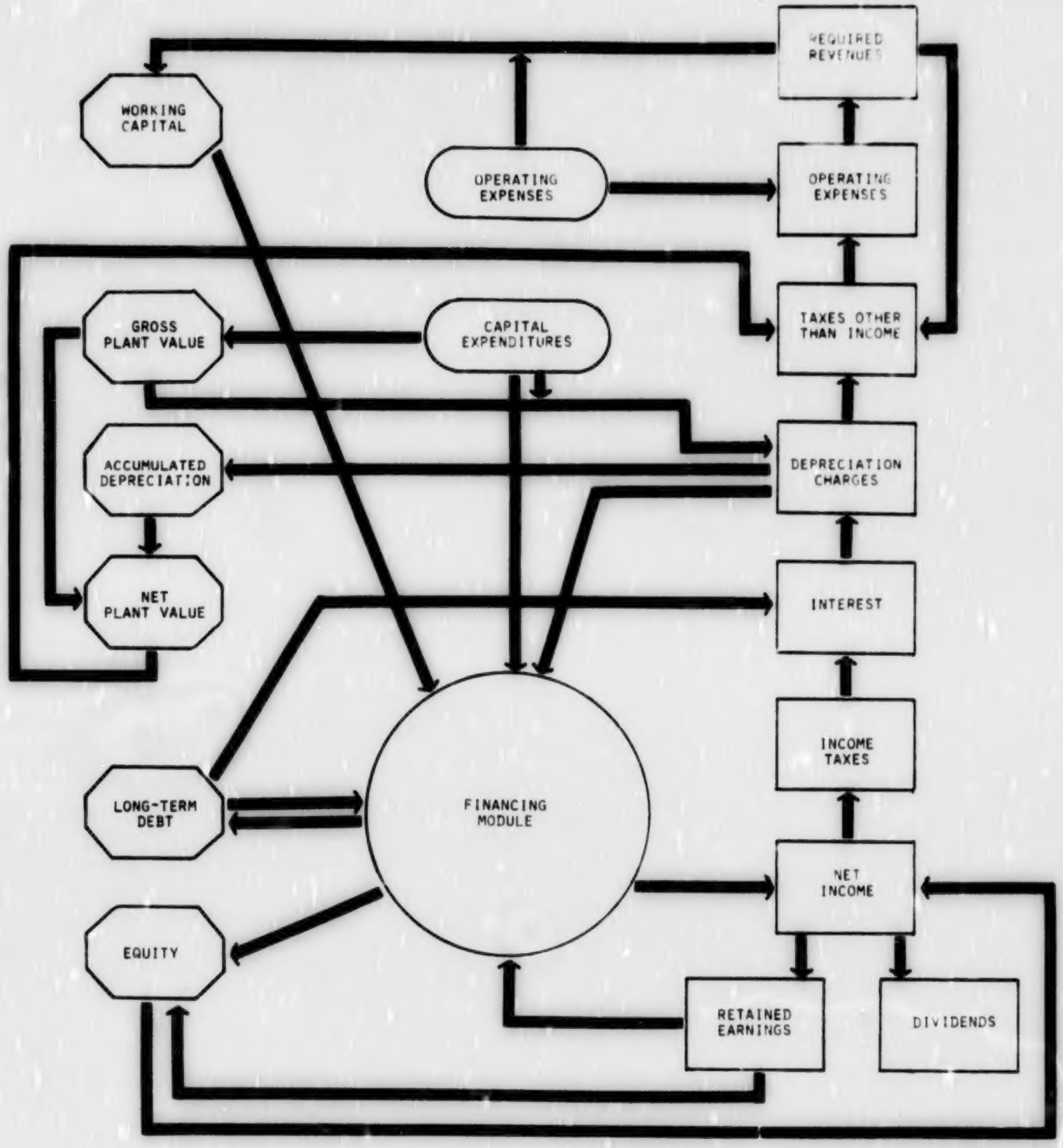
REQUIRED REVENUES
WORKING CAPITAL
OPERATING EXPENSES
OPERATING EXPENSES
GROSS PLANT VALUE
CAPITAL EXPENDITURES
TAXES OTHER THAN INCOME
ACCUMULATED DEPRECIATION
DEPRECIATION CHARGES
NET PLANT VALUE
INTEREST
INCOME TAXES
LONG-TERM DEBT
FINANCING MODULE
NET INCOME
EQUITY
RETAINED EARNINGS
DIVIDENDS

Exhibit 21

REVENUE REQUIREMENTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT

1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Cost Category			
Sales Taxes	$13.44	$0.23	$0.23
Operations and Maintenance Expenses	282.87	2.53	2.34
Depreciation	13.76	0.83	0.90
Property Taxes	3.15	0.27	0.27
Net Interest Charges	4.41	0.41	0.45
Federal and State Income Taxes	7.06	0.50	0.51
Net Income	13.92	0.98	1.00
Total	$338.61	$5.75	$5.68

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm (Steel) projections

Exhibit 22

REVENUE REQUIREMENTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Source of Requirements[1]				
Iron and Steel Production	$94.87	$114.54	$125.55	$334.95
Water PCE In Place	0.93	0.95	0.93	2.80
Air PCE In Place	0.32	0.29	0.26	0.85
Total Baseline	$96.11	$115.78	$126.73	$338.61
Additional Water PCE to meet:				
BPCTCA Guideline	$0.58	$1.20	$1.11	$2.90
BATEA Guideline	0.03	0.21	0.67	0.92
NSPS Guideline	0.03	0.14	0.24	0.41
Storm Runoff Guideline	*	0.04	0.16	0.20
Other Water Requirements	0.07	0.32	0.93	1.32
Total Water	$0.73	$1.92	$3.11	$5.75
Additional Air PCE to meet:				
Stack Emission Standard	$0.69	$1.10	$1.00	$2.78
Fugitives Emission Standard	0.10	0.99	1.35	2.44
Other Air Requirements	0.07	0.16	0.24	0.47
Total Air	$0.86	$2.24	$2.59	$5.68

*less than $5 million

[1] Pollution control equipment denoted as PCE

Source: PTm (Steel) projections

Exhibit 23

AVERAGE PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT FOR SELECTED YEARS

1974-1983

(1975 dollars per ton of steel shipments)

	1974[a]	1977	1980	1983
Source of Effect[1]				
Iron and Steel Production	$361.09	$341.17	$350.76	$361.96
Water PCE In Place	3.61	3.12	2.79	2.57
Air PCE In Place	1.32	0.99	0.81	0.68
Baseline Price	$366.01	$345.28	$354.36	$365.21
Additional Water PCE to meet:				
BPCTCA Guideline		$2.62	$3.64	$2.96
BATEA Guideline		0.19	0.93	2.22
NSPS Guideline		0.21	0.50	0.80
Storm Runoff Guideline		0.02	0.19	0.53
Other Water Requirements		0.38	1.30	3.09
Total Water		$3.42	$6.56	$9.60
Additional Air PCE to meet:				
Stack Emission Standard		$2.98	$3.15	$2.70
Fugitives Emission Standard		0.54	4.04	3.70
Other Air Requirements		0.30	0.54	0.75
Total Air		$3.82	$7.73	$7.15

[1] Pollution Control equipment denoted as PCE

[a] 1974 included as the last year for which data on Pollution Control equipment actually installed is available.

Source: PTm (Steel) projections

Exhibit 24

PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY STEEL PRODUCT

1983

(1975 dollars per ton of steel product)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Steel Product			
Direct Shipments of Ingots, Blooms, Billets and Slabs	$219.68	$3.36	$4.63
Heavy Structurals and Rails	281.95	5.84	5.96
Nails and Wire Products	482.25	16.06	9.25
Bars and Light Structurals	330.59	9.81	7.02
Cold Finished Bars	332.18	11.47	7.04
Seamless Pipe and Tubing	384.88	10.25	7.66
Welded Pipe	417.35	11.99	7.45
Hot Rolled Sheet and Strip	289.28	6.69	5.77
Galvanized Products	492.63	13.95	9.15
Tin and Other Plated Products	521.56	14.60	9.43
Cold Rolled Sheet and Strip	406.48	11.24	8.01
Plates	367.03	7.17	6.54

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm (Steel) projections

Exhibit 25

PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY STAGE OF PRODUCTION[1]

1983

(1975 dollars per ton of steel production)

	Baseline Conditions[2]	Pollution Control Equipment	
		Water	Air
Process Equipment			
Raw Materials Preparation	$182.98	$1.00	$3.10
Ironmaking	8.12	0.89	1.25
Steelmaking	54.23	0.94	2.80
Casting and Forming	30.36	1.49	-
Finishing Mills	89.52	5.28	-
Total	$365.21	$9.60	$7.15

[1] Price effects are computed on the basis of a weighted average of steel products and process-by-process yields.

[2] Includes pollution control equipment placed into service prior to 1975.

Source: PTm (Steel) projections

Exhibit 26

PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY PROCESS[1]

1983

(1975 dollars per ton of unit operation output)

	Baseline Conditions[2]	Pollution Control Equipment	
		Water	Air
Raw Materials Preparation			
Ore Yard	$34.32	$0.03	-
Coal Yard	60.09	0.03	-
Scrap Yard	114.81	0.03	-
Sinter Strand	12.32	0.13	$1.04
Coke Ovens	4.27	1.66	5.38
Ironmaking			
Blast Furnace	8.63	0.97	1.40
Steelmaking			
Open Hearth Furnace	56.55	0.86	3.59
Basic Oxygen Furnace	29.14	0.42	1.16
Electric Furnace	56.45	0.48	3.63
Vacuum Degassing	0.44	0.60	-
Casting and Forming			
Continuous Casting			
Billets and Blooms	13.35	0.82	-
Slabs	45.23	0.90	-
Conventional Casting			
Ingot Casting	-	-	-
Breaking--Blooms	19.63	1.18	-
Breaking--Billets	29.75	1.79	-
Breaking--Slabs	8.30	0.91	-
Finishing Mills			
Heavy Structural	19.22	1.75	-
Hot Rolled Bar and Rod	54.49	4.75	-
Wire Product	135.13	5.76	-
Cold Finished Bar	1.59	1.67	-
Seamless Pipe and Tube	86.40	4.78	-
Hot Rolled Strip	36.98	2.35	-
Pickling and Oiling	13.43	1.64	-
Welded Pipe and Tube	76.91	3.27	-
Cold Rolled Strip	56.84	2.29	-
Hot Coating--Galvanizing and Terne	69.89	2.26	-
Cold Coating--Tin and Chrome	98.82	2.91	-
Plate	79.41	2.96	-

[1] Price effects represent value added (including the purchase of raw materials) at each unit operation.

[2] Includes pollution control equipment placed into service prior to 1975.

Source: PTm (Steel) projections

Exhibit 27

SOURCES AND APPLICATIONS OF FUNDS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT

1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Applications of Funds			
Capital Expenditures	$8.72	$1.76	$2.09
Increase in Working Capital	1.15	0.02	0.04
Refunding of Long-Term Debt	0.47	-	-
Total Applications	$10.34	$1.78	$2.13
Sources of Funds			
Depreciation	$4.31	$0.07	$0.09
Retained Earnings	2.25	0.12	0.14
Subtotal--Internal Sources	$6.56	$0.19	$0.23
Issues of Long-Term Debt	$2.29	$0.43	$0.53
Issues of Common Stock	1.49	1.15	1.37
Subtotal--External Financing	$3.77	$1.59	$1.90
Total Sources	$10.34	$1.78	$2.13

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm (Steel) projections

Exhibit 28

SOURCES AND APPLICATIONS OF FUNDS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT

1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Applications of Funds			
Capital Expenditures	$27.50	$3.57	$3.25
Increase in Working Capital	4.21	0.21	0.19
Refunding of Long-Term Debt	1.22	-	-
Total Applications	$32.93	$3.78	$3.44
Sources of Funds			
Depreciation	$13.76	$0.83	$0.90
Retained Earnings	6.18	0.47	0.48
Subtotal--Internal Sources	$19.94	$1.29	$1.38
Issues of Long-Term Debt	$6.19	$0.75	$0.66
Issues of Common Stock	6.79	1.73	1.40
Subtotal--External Financing	$12.99	$2.49	$2.06
Total Sources	$32.93	$3.78	$3.44

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm (Steel) projections

Exhibit 29

EXTERNAL FINANCING REQUIREMENTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Source of Requirements[1]				
Iron and Steel Production	$3.74	$4.80	$4.69	$13.23
Water PCE In Place	0.04	(0.10)	(0.09)	(0.15)
Air PCE In Place	(0.01)	(0.05)	(0.04)	(0.09)
Total Baseline	$3.77	$4.65	$4.56	$12.99
Additional Water PCE to meet:				
BPCTCA Guideline	$1.20	$(0.07)	$(0.29)	$0.84
BATEA Guideline	0.12	0.45	0.14	0.71
NSPS Guideline	0.11	0.10	0.13	0.33
Storm Runoff Guideline	0.02	0.08	0.03	0.12
Other Water Requirements	0.15	0.26	0.09	0.49
Total Water	$1.59	$0.81	$0.09	$2.49
Additional Air PCE to meet:				
Stack Emission Standard	$1.16	$(0.08)	$(0.15)	$0.93
Fugitives Emission Standard	0.62	0.51	(0.17)	0.95
Other Air Requirements	0.12	0.06	*	0.18
Total Air	$1.90	$0.48	$(0.32)	$2.06

*Less than $5 million

[1] Pollution Control Equipment denoted as PCE.

Source: PTm (Steel) projections

Exhibit 30

ENERGY CONSUMPTION FOR IRON AND STEEL PRODUCTION BY TIME PERIOD
1975-1983
(quadrillion Btu)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	4.28	5.11	5.40	14.79
Ironmaking	(1.07)	(1.26)	(1.34)	(3.67)
Steelmaking	0.82	0.93	0.96	2.71
Casting and Forming	0.74	0.87	0.87	2.48
Finishing Mills	1.82	2.15	2.28	6.25
Total	6.59	7.80	8.17	22.56

Source: PTm (Steel) projections

Exhibit 31

ENERGY CONSUMPTION FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

1975-1983

(quadrillion Btu)

	1975-1977	1978-1980	1981-1983	1975-1983
Source of Consumption[1]				
Iron and Steel Production	6.59	7.80	8.17	22.56
Water PCE In Place	0.05	0.06	0.06	0.17
Air PCE In Place	0.07	0.08	0.07	0.22
Total Baseline	6.71	7.94	8.30	22.95
Additional Water PCE to meet:				
BPCTCA Guideline	0.03	0.10	0.11	0.24
BATEA Guideline	-	0.01	0.05	0.06
NSPS Guideline	-	0.01	0.02	0.03
Total Water	0.03	0.12	0.18	0.33
Additional Air PCE to meet:				
Stack Emission Standard	0.01	0.01	0.02	0.04
Fugitive Emission Standard	-	0.03	0.04	0.07
Total Air	0.01	0.04	0.06	0.11
Total Energy Consumption	6.75	8.10	8.54	23.39

[1] Pollution control equipment denoted as PCE.

Source: PTm (Steel) projections

Exhibit 32

EMPLOYMENT FOR IRON AND STEEL PRODUCTION FOR SELECTED YEARS

1974-1983

(thousands of jobs)

	1974	1977	1980	1983
Process Equipment				
Raw Materials Preparation	54.8	52.9	52.9	52.5
Ironmaking	21.9	21.3	21.2	21.0
Steelmaking	120.0	111.2	107.6	104.1
Casting and Forming	73.5	71.6	75.4	78.7
Finishing Mills	194.2	185.2	185.9	185.8
Total	464.4	442.3	443.0	442.1

Source: PTm (Steel) projections

Exhibit 33

EMPLOYMENT FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT[1] FOR SELECTED YEARS

1974-1983

(thousands of jobs)

	1974	1977	1980	1983
Source of Employment[2]				
Iron and Steel Production	464.4	442.3	443.0	442.1
Water PCE In Place	1.9	2.0	2.0	2.0
Air PCE In Place	0.5	0.4	0.4	0.4
Total Baseline	466.8	444.6	445.3	444.5
Additional Water PCE to meet:				
BPCTCA Guideline		0.8	1.6	1.7
BATEA Guideline		0.1	0.3	1.0
NSPS Guideline		0.1	0.2	0.4
Other Water Requirements		0.4	1.9	5.9
Total Water		1.4	4.0	9.0
Additional Air PCE to meet:				
Stack Emission Standard		0.1	0.1	0.1
Fugitive Emission Standard		-	2.4	2.5
Other Air Requirements		0.3	0.6	1.0
Total Air		0.4	3.1	3.6
Total Employment		446.4	452.4	457.1

[1] Includes process-related direct and indirect employees only.

[2] Pollution control equipment denoted as PCE.

Source: PTm (Steel) projections

Exhibit 34

PTm (STEEL) MAJOR COMPONENTS

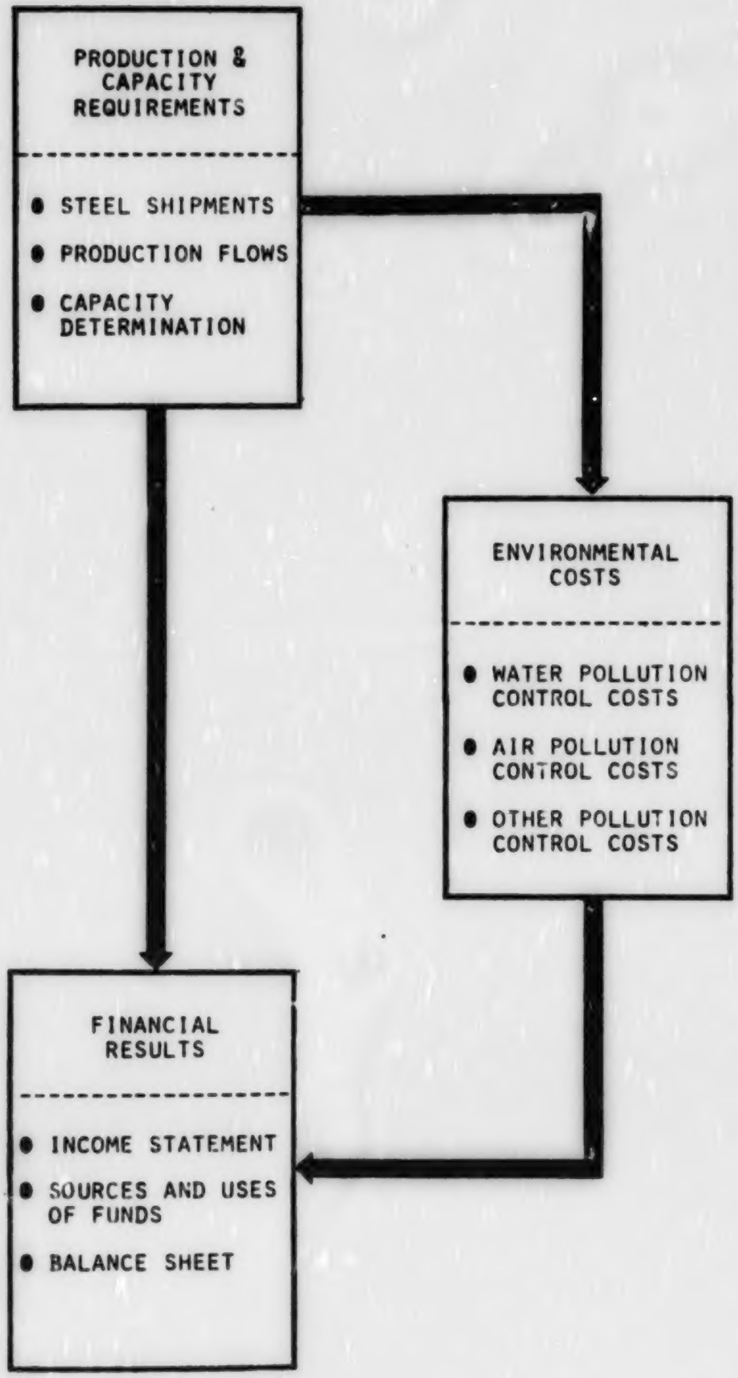
PRODUCTION & CAPACITY REQUIREMENTS
● STEEL SHIPMENTS
● PRODUCTION FLOWS
● CAPACITY DETERMINATION
ENVIRONMENTAL COSTS
● WATER POLLUTION CONTROL COSTS
● AIR POLLUTION CONTROL COSTS
● OTHER POLLUTION CONTROL COSTS
FINANCIAL RESULTS
● INCOME STATEMENT
● SOURCES AND USES OF FUNDS
● BALANCE SHEET

Exhibit 35

ASSOCIATION OF WATER POLLUTION TREATMENT SUBCATEGORIES WITH PRODUCTION PROCESSES

WATER POLLUTION TREATMENT PROCESS	PRODUCTION PROCESSES
By-Product Coking--Alternate I By-Product Coking--Alternate II	Coke Ovens
Sintering	Sinter Strand
Blast Furnace	Blast Furnace
Open Hearth Furnace	Open Hearth Furnace
Basic Oxygen Furnace--Wet Basic Oxygen Furnace--Semi-wet	Basic Oxygen Furnace
Electric Furnace--Wet Electric Furnace--Semi-Wet	Electric Furnace
Vacuum Degassing	Vacuum Degassing
Continuous Casting	Continuous Casting--Billets and Blooms Continuous Casting--Slabs
- - - - - - - - - -	Conventional Casting--Billets, Blooms, and Slabs
Hot Forming--Primary	Primary Breaking--Blooms Primary Breaking--Slabs
Hot Forming--Section	Primary Breaking--Billets Heavy Structural Hot Rolled Bar and Rod Wire Product
Hot Forming--Hot Strip and Sheet	Hot Rolled Strip
Hot Forming--Plate	Plate
Pipe and Tube--Integrated, Seamless, and Other	Seamless Pipe and Tube
Pipe and Tube--Integrated, Welded	Welded Pipe
Pipe and Tube--Isolated, Seamless, or Welded	Seamless Pipe Welded Pipe
Pickling--H_2SO_4 Batch Concentrates and Rinses	Hot Rolled Bar and Rod Wire Production Cold Finished Bar Pipe and Tube--Seamless
Pickling--H_2SO_4 Continuous Concentrates and Rinses, Neutralization Pickling--H_2SO_4 Continuous Concentrates and Rinses, Acid Recovery	Hot Rolled Strip
Pickling--HCL Continuous Concentrates and Rinses, Neutralization (Alternate I) Pickling--HCL Continuous Concentrates and Rinses, Acid Recovery (Alternate II)	Hot Rolled Strip
Cold Rolling--Recirculation Cold Rolling--Direct Application Cold Rolling--Combination	Cold Reduction and Finishing
Hot Coating--Galvanizing Hot Coating--Terne	Hot Coating--Galvanizing Hot Coating--Terne
Cold Coating--Tin Cold Coating--Chrome	Cold Coating--Tin and Other Plated Products

Exhibit 36

COMPARISON OF PRODUCT CATEGORIES

TBS PRODUCT CATEGORIES	AISI PRODUCT CATEGORIES
Direct Shipments of Ingots, Slabs, Billets and Blooms	Ingots and Steel Castings; Blooms, Slabs, Billets, Sheet Bars; Tube Rounds
Heavy Structurals and Rails	Heavy Structural Shapes; Steel Piling; Rails
Nails and Wire Products	Nails and Wires
Bars, Light Structurals, including Bars and Wire Rods	Wire Rods; Bars--Hot Rolled, Light Shaped, and Reinforcing; Tool Steel
Cold Finished Bars	Bars--Cold Finished
Seamless Pipe	Pipes and Tubing--Oil Country Goods and Pressure
Welded Pipe	Pipes and Tubing--Standard, Line, Mechanical, Structural, and Stainless
Hot Rolled Sheet and Strip	Sheets and Strip--Hot Rolled; Skelp
Galvanized Products	Sheets & Strip--Galvanized Hot Dipped and Galvanized Electrolytic
Tin Plating and other Plated Products	Tin Plate--Electrolytic and Hot Dipped; Tin Free Steel; Tin Mill Products--all other; Sheets and Strip--all other Metallic Coated
Cold Rolled Sheet and Strip	Black Plate; Sheets--Cold Rolled; Sheets and Strip--Electrical; Strip--Cold Rolled
Plate	Plates

APPENDIX A

HISTORICAL PERSPECTIVE ON THE U.S. STEEL INDUSTRY

APPENDIX A

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APPENDIX A

LIST OF EXHIBITS

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INDUSTRY STRUCTURE

In 1974 the United States Iron and Steel Industry was composed of 200 steel companies with nearly 400 plants operating in 38 states. A further breakdown of industry activities is as follows:[1]

200 companies operate steel facilities

30 produce pig iron

95 produce raw steel

78 produce carbon-quality steel

54 produce alloy-quality steel

28 produce stainless-quality steel

15 produce tool steels

50 make steel bars

50 make wire products

30 make plates

60 make pipe and tubing

28 make cold rolled sheets

These bare statistics, however, give an inaccurate picture of the steel industry profile by suggesting that the industry is broad-based both in competition among the membership and in geographic location. An historical look at the major producers and geographic spread within the industry will offer quite a different perspective of industry structure.

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[1] *American Iron and Steel Institute*

PRODUCTION CONCENTRATION

Organizationally and operationally, the steel industry of the 1890s and that of the 1970s are radically different. According to early records of the American Iron and Steel Association, in 1890 the industry consisted of 719 "whole" establishments engaged in the production of iron and steel.[2] In 1892, 25 years after the opening of the first open hearth furnace in this country, the four largest firms accounted for less than 30 percent of steelmaking capacity. The trend towards concentration began shortly thereafter with a rash of mergers. In 1901 United States steel joined together 12 steel companies, thereby agglomerating two-thirds of the national capacity into one firm.

The concentration of production which developed early in the century persisted through the 1930's. Until World War II, five companies dominated the industry. These were U.S. Steel, Bethlehem, Republic, Jones and Laughlin, and Younstown Sheet & Tube, in that order. Exhibit A-1 sets out the ranking of steel companies from the World War II era to the present. This lineup of the top ten companies has not altered a great deal since World War II, as set forth in Exhibit A-2, which displays the contribution of total industry shipments by major companies. In 1950 the top four companies contributed 64 percent of total industry shipments. The top ten contributed 80 percent and the top 20 companies together totalled almost 90 percent of national shipments. In 1974 the corresponding categories of producers contributed

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[2] *American Iron and Steel Institute, "Profile of an American Industry - STEEL", Reprint from STEELWAYS Magazine, May/June, 1969*

50 percent, over 75, and almost 90 percent of total shipments, respectively. Statistics for various years during the period 1945-1970 exhibit the same concentration of volumes shipped.

GEOGRAPHIC CONCENTRATION

Although steel is now made throughout the length and breadth of the country, proximity to raw materials, to transportation, and to steel-consuming industries continues to contribute to geographic concentration patterns. This geographic relationship between production facilities and raw materials and reduced transportation of the tremendous volumes of supplies which are required for the production of iron ore, which supplied four-fifths of all iron ore consumed in U.S. blast furnaces, is the Great Lakes region. About 55 to 60 percent of all coking coal is mined in the Pennsylvania, Ohio, and Indiana region. It is easily understood then that in 1974 approximately 75 percent of steel production was centered in the Middle Atlantic and East North Central states of New York, Pennsylvania, Ohio, Indiana, Illinois, and Michigan. A roster of the 14 states which produced 95 percent of raw steel would add Maryland, Kentucky, Mississippi, Alabama, Georgia, South Carolina, Colorado, Texas, and California.

In the early 1960's there was substantial thought given to moving facilities away from sources of raw materials and toward the "steel deficit" consumer markets, particularly on the West Coast. Some analysts feel, however, the future growth on the West Coast of large integrated producers is limited. The general attitude is that the nature of West Coast manufacturing tends towards assembly rather than metal fabrication, and that continued strong import competition from the Japanese has dissuaded steelmakers from including West Coast production facilities in thier long-range plans. This was evidenced in 1971, when Bethlehem Steel announced it was dropping its plans to build a fully integrated mill on a deepwater port in Richmond, California.

Future changes in raw materials availability are not expected to have much effect on the established geographic concentration patterns. By the late 1950's, because existing high-grade ore supplies (50 percent ore content) were becoming depleted, the industry faced a choice of importing ores, seeking out new ore fields in other geographic areas, or working with the available low-grade ore. The industry chose to retain production facilities in existing locations and transport raw materials from greater distances to production sites. To do so economically, the industry developed a new technology, to concentrate lower-grade ore (25 percent or less) to 70 percent. This "beneficiated" ore, called taconite, is mined in Minnesota. It is shipped via water transport (which is far cheaper than overland rail transport) across the Great Lakes to existing facilities.

CHANGING STRUCTURE: 1965-PRESENT

Since the mid-1960s certain developments have begun to alter the historical profile of the industry. The general industrial trend toward diversification has taken two basic forms in its effect on the steel industry. These have been acquisition of steel companies by conglomerates and diversification by major steel producers.

In the early 1960s, steel companies badly needed more modern production facilities. Investment in the steel industry was unattractive since steel companies had experienced low rates of return on both revenue and equity. At the same time, small and marginal producers were plagued with obsolete equipment and huge overhead costs. The heavy investment in fixed assets, which is characteristic of steel companies, provided depreciation with resulting large cash flows even at low profitability rates. This cash flow made steel companies prime takeover targets, despite unsatisfactory profits and the low price of steel equities in relation to book value throughout the early 1960s.

Lone Star Steel was absorbed by the Philadelphia and Reading Corporation. In 1967 Ling-Temco-Vought (now the LTV Corporation) gained control of the Jones and Laughlin Steel Corporation, which was then seventh-ranked among domestic producers. Other acquisitions of note by conglomerates include the Lykes Corporation purchase of eighth-placed Youngstown Sheet and Tube, Colt Industry's acquisition of Crucible Steel, and NFV Company's acquisition of Sharon Steel.

During this time, some steel companies began to extend their interests beyond traditional steelmaking efforts, seeking to develop more profitable lines of business. Some producers have expanded into diverse areas such as insurance, home building, chemicals and aircraft manufacturing. A greater number of steel companies have extended into related businesses such as raw material supply, fabrication of steel products and transport of finished goods. In 1974 approximately 20 of 200 steel companies representing almost 90 percent of industry shipments were integrated from the blast furnace through finishing facilities.[3] It is common for integration in the largest companies to continue backwards through coking and pre-coking efforts, such as ownership of coal mines, limestone quarries, and ore fields, as well as control of water transport systems and feeder railroads.

Steel companies have invested particularly heavily in mining operations to insure supplies or iron ore. Major steel producers often have interests in two or more ore companies and frequently band together in joint ventures for large scale mining. In 1974, of top iron producers mining over one million long tons of crude ore per year, six of the group of fifteen were steel corporations.

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[3] *American Iron and Steel Engineer,* *Directory of Iron and Steel Plants*

As a result of these diversification patterns, the American steel industry of the 1970s earns a growing proportion of its revenues and profits from non-steel operations. The balance sheet and income statement data which are collected and reported annually by the AISI thus must be refined somewhat in examining the financial realities of steelmaking. According to current industry data for the top five steel companies, steel operations account for approximately 40 percent of their income, while 60 percent comes from non-steel operations.[4] The same group of companies has about 70 percent of assets tied to steelmaking and 30 percent to other areas. The rest of the steel industry uses a greater portion of its assets in steel operations.

EMERGENCE OF MINI-MILLS

The other significant event which has altered the historical profile of the steel industry in the last decade has been the emergence of "mini-mills" in the areas outside primary geographic production regions. A mini-mill produces between 50,000 and 250,000 tons of raw steel annually. The mini-mill typically employs electric furnaces, continuous casting, and steel finishing mills to produce basic or speciality steel products for local markets. Thus the only raw material required is scrap steel which is available in quantity near user markets. Because of the small size of facilities and almost total non-reliance on geographically centralized raw materials markets, construction of mini-mills in more remote areas of the country is possible.

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[4] *American Iron and Steel Institute, correspondence from Ken Allen, Director of Statistical Services to TBS, November, 1975*

In 1974, a national population of 40 mini-mills produced only 3 percent of total U.S. steel shipments. It should be noted, however, that though the relative output of mini-mills may be small, this tonnage adds an important flexibility to the volume of available steel supply. Further, the value added to total steel revenues from mini-mills is a substantially larger contribution than their tonnage would suggest, since they frequently specialize in alloy and stainless steel, which can offer up to seven times more revenue per ton than common-grade steel.[5]

Takeovers, consolidations, vertical acquisitions, and mini-mills may bring further changes in the structure of the steel industry through the remainder of the century. It should be expected, however, that, even considering the movements which have occurred since 1965, the basic oligopolistic organization of the steel industry will remain.

PROCESS PROFILE

A steel plant is a series of processes operating independently and sequentially to manufacture products. The terms integrated, semi-integrated, and non-integrated are used to describe the configuration of processes at plants producing steel goods. Historically, integrated plants were defined as those which employed coke oven facilities, blast furnaces, and steel furnaces at the same location, while semi-integrated plants operated from the blast furnace onward.[6] More recently, the category definitions have been altered somewhat. On a more detailed level, the term "integrated" commonly refers to plants having blast furnaces where the principal commercial activity is the production of carbon steel.[7] Non-integrated plants are those with no blast furnace which purchase iron and scrap steel as charge and operate steel furnaces and finishing operations. Of the 200 companies operating steel facilities in 1974, 95 produced raw steel at 155 different plant locations. Approximately 20 companies at 43 different sites operated integrated plants. Nearly 80 percent of these also ran coke oven batteries. About 112 sites were non-integrated steelmaking plants, 87 percent of which utilized electric furnaces only. Some 215 additional plant sites had no steelmaking facilities, but rather purchased ingots, blooms and other semi-finished goods for use in finishing and fabricating mills.[8]

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[5] *U.S. Department of Commerce, Bureau of the Census,* *__Current Industrial Reports - Steel Mill Products - Series MA33B__.*

[6] *American Iron and Steel Institute, Statistical Department.*

As set out in Exhibit A-3, there are 23 different processes in the manufacture of steel products. Operations from the raw materials yard through ingot and continuous casting are considered steelmaking processes and are referred to in this study as "Phase I processes." Steel forming and finishing processes include primary breaking of ingot steel through final end-product finishing and are referred to as "Phase II operations."

The AISI report, Steel and the Environment: A Cost Impact Analysis, which was released in 1975, profiled the steel industry as it existed in 1972 on a process level.

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[7] *American Iron and Steel Engineer, Directory of Iron and Steel Plants*

[8] *American Iron and Steel Institute, Iron and Steel Works Directory of the U.S. and Canada*

This breakdown was compiled from data gathered on a company-by-company, plant-by-plant basis and, as such, represents a comprehensive framework within which to examine pollution control effects at individual operations. Exhibit A-4 summarizes this process profile, setting out numbers of plants by age in each of several process groupings. Exhibit A-5 details total productive capacity by size of facilities in the same categories.

On average, U.S. steel facilities have been in service for 20 years or more. In comparison with Japanese and European steel works, U.S. capacity is old. In the raw materials area, over 90 percent of all ore and coal yards were built before 1955. Sixty-seven percent of all existing coke ovens have been in operation since 1955 and 33 percent of these date to before 1945. In the iron-making area, 94 percent of all U.S. blast furnaces were built pre-1955.

Steelmaking has undergone substantial technological change since the introduction of the basic oxygen furnace in 1955. In that year open hearths produced 90 percent of the raw steel. By the beginning of 1972, open hearths contributed only 30 percent of total production and basic oxygen furnaces represented 54 percent. In that year 87 percent of existing open-hearth capacity had been built prior to 1955. The average size open-hearth furnace shop was about 30 percent smaller in size than the average basic oxygen furnace shop, and required a considerably longer heat time. Electric furnaces produced 16 percent of total raw steel production in facilities which individually were small in output, but which represented almost 50 percent of the total number of steelmaking furnaces in operation.

Raw steel is formed either by conventional casting into ingots or by the new continuous casting methods into billets and slabs. In 1972, 92 percent of raw steel was ingot cast in facilities which were almost equally divided between pre- and post-1955 construction. Seventy-six percent of this volume is cast in large facilities, averaging about four million net tons of output per year. More steel is continuously cast into slabs than into billets but in total this newer method accounts for only 7 percent of total casting.

After casting, the raw steel is turned into products in finishing mills. The majority of finishing facilities are also old, between 60 and 70 percent were built before 1955.

From a pollution control point of view, air emissions and water effluent wasteloads are contributed separately by each process; thus the problem of pollution abatement is process-specific. This study, which examines the economic impact of pollution control on the steel industry, analyzes individual processes rather than typical plants or companies, and describes total impacts on the industry as the sum of impacts on each process.

STEEL AND THE AMERICAN ECONOMY

Throughout this century the United States iron and steel industry has commanded a pivotal position in the structure of the national economy. It is a "basic" industry which has catalyzed economic growth in the U.S. since the introduction of mass production techniques over 100 years ago. In 1974 steel accounted for more than 90 percent of all metal used in this country. Almost 40 percent of the industrial working force in the U.S. is involved in the making, shaping, or use of steel for its livelihood. The steel industry offers direct employment to approximately 3 percent of the over 20 million people employed in manufacturing and is second only to the automobile and aircraft industries as a primary employer of workers producing durable goods.[9]

THE U.S. AND WORLD STEEL SUPPLY

Growth in steel production in the U.S. has closely tracked the nation's climb to a position of leadership among world powers. As set forth in Exhibits A-6 and A-7 which chart the course of U.S. steel exports since World War II, the U.S. has consistently been a primary source of steel. Its share of the world steel trade decreased, however, from 15 percent in 1950 to below 5 percent in 1974.

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[9] *AISI, Profile of an American Industry - STEEL, STEELWAYS Magazine, May/June, 1969*

The U.S. has consistently ranked first or second among world producers of raw steel, relinquishing the lead position to the USSR only in 1974. Exhibit A-8 ranks the leading steel producing nations during the years since World War II according to steel production, while Exhibit A-9 sets forth the tonnage contribution of each to total world production. In 1945 the United States contributed 63.6 percent of world raw steel production.[10] This share shifted dramatically downward after 1945, as Europe and Japan rebuilt war-torn steel facilities and as developing nations made self-sufficiency in steel operations a key step in the path to industrialization. By 1974 the U.S. contribution had diminished to 18.6. During this period, total U.S. production had risen over 70 percent; however, world production had increased nearly 625 percent, thus outstripping the domestic rate many times over. Imports of finished steel products to the U.S. concurrently increased from less than 1 percent of apparent consumption in 1945 to over 13 percent in 1974.[11]

DOMESTIC CONSUMPTION

In the domestic market, the strategic relationship of steel to major market and economic sectors is reflected in historical data which demonstrate the steady contribution of steel industry revenues to Gross National Product (GNP). From 1945 to 1974 the steel industry contributed between 2.0 and 3.8 percent of total gross national product. During the same time period the manufacturing sector increased as a portion of GNP; therefore, steel industry contribution to the manufacturing sector decreased relatively from 11.3 percent in 1950 to 7.5 percent in 1970.

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[10] *"Raw steel" is defined as the output of open hearth, basic oxygen furnace, and electric furnaces prior to casting.*

[11] *"Apparent consumption" is defined as shipments plus imports minus exports.*

As suggested by Exhibit A-10, steel shipments and GNP are highly correlated. A closer look at annual fluctuations in steel shipments reveals that historically they have reflected the vigor of the overall economy, except possibly during periods of labor disputes. Demand sharply accelerates in periods when domestic and economic indicators are strong and decreases in periods of recession. Primary steel markets, which include the capital goods, the automobile, and the construction industries are extremely sensitive to changes in economic activity levels. Steel demand and output thus show a sharp responsiveness to these cyclical trends.

In 1955, ten years after the close of World War II, the United States consumed 37.8 percent of the world supply of steel. By 1974 world consumption had increased so much that the U.S. usage rate had declined to 20.8 percent. However, America remains the largest national market for steel in the world.[12]

Since World War II, growth in apparent steel consumption in the U.S. has averaged 3.2 percent per year. Fluctuations in this average are wide, however, due to the uneven growth of the economy, which has been marked by both recession and expansion. Exhibit A-11 displays the uneven curve of apparent consumption growth in the post-World

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[12] *American Iron and Steel Institute, Steel Industry Economics and Federal Income Tax Policy, June, 1975*

War II period. Projections of the growth rate for apparent consumption of steel products show a decline to 2.3 percent in the 1975-1985 period. This suggests that the intensity of steel usage in the U.S. is slowing down.[13] Although steel will undoubtedly remain among the most widely-used industrial materials in this country, its relative importance will decline as primary economic growth expands in the service sectors rather than the industrial sector.

STEEL MARKETS

In addition to examining the overall patterns of steel consumption in the United States, it is also important to take a closer look at individual market sectors where the greatest amounts of steel shipments occur. Exhibit A-12 displays the growth of prominent steel markets since World War II. It is clear that significant volumes are shipped to both heavy capital goods industries and to consumer-oriented industries. These markets are characterized historically by cyclical patterns which result in fluctuations in the level of steel demand.

Since World War II the automobile industry has consistently been the largest single customer of the steel industry. The automobile sector is extremely sensitive to consumer spending patterns. For example, in the recession period 1969-1970, steel shipments to the auto sector dropped 29 percent.

In the last two decades, several secular trends have developed which seemingly limit the expansion of steel usage in the domestic automobile market. One has been the

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[13] *International Iron and Steel Institute, Projection 85, 1975*

increased market for foreign cars by domestic users. Another is that improvements in the quality and durability of steel have allowed substantial decreases in the tonnage of steel used per car. A third is that materials other than steel have been substituted in the manufacture of motor vehicles. Aluminum and plastic are being used in increasing amounts because they are lighter in weight and more resistant to corrosion than steel. Finally, recent trends toward smaller models of domestic cars reduces the amount of steel per car.

Governmental regulations on the auto industry are expected to affect steel demand. Future volumes of steel shipments will be determined in part by the effects which environmental and energy-usage issues have on the auto industry. As in other countries, pollution control legislation on the auto industry potentially may have an effect on the steel industry as well.

The second largest consumer of steel shipments is the construction industry. Since World War II, approximately 15 to 20 percent of total direct shipments of steel have been sent to this sector. This amount may be understated, however, since substantial additional tonnages of construction steel move through steel service centers, a market which in the same period has represented another 18 to 20 percent of total shipments.

Expenditures for residential and non-residential construction are without question extremely sensitive to business cycles, and in fact, decreased expenditures in this sector frequently foreshadow the full impact of a recession.

As in the case of the automobile industry, shipments to the construction industry have dropped in recent years as reinforced concrete and other building materials are substituted for steel. In addition, stronger steel has resulted in fewer tons per unit of construction being used. However, future use of steel in construction is expected to be strong throughout the late 1970s, as a preference grows for steel in single-family homes and mobil homes.

Changes have occurred in other segments as well. In the 1960s the steel industry's fastest growing customer was the steel service center, which is, of course, a middleman for a variety of small end-users. Shipments to the container industry have also grown steadily, although the future of this market is somewhat clouded by the uncertainty of finding a solution to the solid waste disposal problem which cans present. Markets such as railroad and the military, which historically were heavy steel consumers in the pre-World War II era, have decreased substantially.

STEEL PRODUCTS

The industry's products comprise many types of steel. These include: carbon steel, which is the original "workhorse" steel, and which historically has accounted for over 90 percent of all steel shipments; alloy steels; high-strength low-alloy steels; stainless steel; and tool steels, either carbon or alloy. The allocation of total steel shipments between these three grades has remained fairly constant as suggested in Exhibit A-13.

For statistical purposes, the American Iron and Steel Institute historically has collected data on products in groups. In its study, Steel and the Environment: A Cost Impact Analysis, released in May 1975, end products were agglomerated into twelve catetories, each directly linked to the chain of steelmaking processes discussed earlier in Exhibit A-3. Exhibit A-14, which allocates total steel shipments over the period 1945-1974 into the 12 product categories, points out that by far the biggest group of products, representing over 40 percent in 1974, are sheets and strip required in the manufacture of durable goods. These thin and flat-rolled products increased their shares of total shipments marginally as the U.S. grew more consumer-oriented in the post-war years and demanded more automobiles, refrigerators, containers, etc. Steel plants, another category of thick, flat-rolled products, are vital in such industries as shipbuilding and construction, and consistently represent 8-10 percent of shipments. Bars and light structural shapes, used largely in construction work and automobile manufacture, have accounted for 13-15 percent of shipments in this period.

An examination of the relative revenue contribution of specific products in the steel marketbasket offers a somewhat different perspective than looking at the tonnage share alone would provide. Cold finished bars and tool steel, which represented less than 2 percent of total shipments in 1972, sold for over $480 per ton,[14] or 4 percent of total revenues. Hot-rolled sheets were 17 percent of shipments but sold at approximately $165 per ton, contributing 12 percent of steel sales. Other sheet, strip, and tin-plated

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[14] *U.S. Dept. of Commerce, Bureau of the Census, CURRENT INDUSTRIAL REPORT, - Steel Mill Products - Series MA33B; TBS calculation*

products were high volume, lower-priced goods. Pipe and tubing and wire products were low volume but high in value added to revenues on a per ton basis.

Of particular importance in looking at steel product revenues is the breakout of products by grades of steel used in each. Stainless and high strength alloy steels are significantly more costly to produce than carbon grade, and market prices are correspondingly higher. In the domestic market, stainless steel may be six to seven times more expensive than carbon steel. In certain product lines the higher grades of product are nine to ten times more expensive than the carbon.[15] Clearly then, volume of shipments alone does not explain completely the relative importance of specific individual product lines to the steel industry.

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[15] *IBID, page A-18.*

PATTERNS AND POLICIES IN THE U.S. STEEL INDUSTRY

An overview of the steel industry should include more than capsule summaries of its structure and its role in the American marketplace. Certain historical issues and trends have played dominant roles in determining the character of the industry.

PRODUCTIVE CAPACITY

Planning capacity levels to meet projected steel demand is a strategic issue to the industry. Optimally, the industry would like to avoid "overcapacity" situations, where productive facilities are underutilized. Low levels of operation tend to reduce rates of return substantially. On the other hand, shortages of productive capacity effectively put a ceiling on shipment volume, which tends to limit profits assuming prices are not increased.

Decision-making concerning capacity planning is an area where governmental interest in the steel industry is particularly acute. Because the steel industry is an important element in the national economy, steel productive capacity levels and utilization rates play a key role in the general economy.

In the late 1930's the U.S. steel industry was on average operating at only 40 percent utilization. The industry was accused of having too much capacity, and was cited as one of the major causes of widespread unemployment and of the Depression. By the end of the 1930's, an industry role reversal had occurred, in that the industry was then arguing for the flexibility of added capacity so that it would be ready to accept growth, high employment levels, and the return to normal business levels. In the years immediately prior to the outbreak of World War II, the domestic steel industry assured the government that adequate plant capacity existed to supply armaments required for the national security. However, an expansion program of some ten million tons was planned by industry for the war effort. As the war progressed, the industry experienced great pessimism concerning the absorption of war-related expansion once peacetime returned. In the period from 1940 to 1945, government incentive to industry to continue capacity development programs was offered in the form of accelerated depreciation schedules. By 1949 the industry's pessimism was substantially tempered, as demand increases had led to utilization of existing capacity at 96 percent. Indeed, plans for greater additions were underway.

In the Korean War period, President Truman's concern over adequate levels of productive capacity was a key reason behind his attempts to seize control of the steel industry. This was an era when the major producers were again worried over the possibilities of a wartime overexpansion which would not be easily utilized in the postwar period. In fact, in the post-Korean years, demand was sustained at a very high level, and industry worries concerning expansion again were quelled.

By the mid-1950s the majority of steel mill equipment industry-wide had been in continuous operation for over 40 years. Outmoded production techniques impaired plant utilization rates, labor productivity, and other efficiencies. Particularly with the threat of future growth in imports and competitive materials, major producers launched huge capital expenditures programs to introduce modern technologies.

In 1960 the American Iron and Steel Institute reported that total steel industry capacity was 148.5 million net tons of raw steel, but has not regularly published official capacity estimates since that date. The practice was discontinued principally in the belief that estimates were sometimes being misinterpreted by the economic, government, and financial communities. Only in 1973, during the period of unprecendented worldwide demand for steel products, did the industry again offer information regarding current capacity levels. The estimate of the American Iron and Steel Institute statistical division is that between 155 and 160 million net tons of raw steel capacity was on-line in 1973-1974. The industry argues that the 1973 production level of 150.8 million net tons meant that productive facilities were running straight out at 100 percent utilization. Shipments in that year of 111.4[16] million net tons were achieved only through a tremendous drain on inventory. Demand exceeded the maximum capacity to produce steel. Given these statistics, the industry has projected a required addition of 25-30 million net tons of capacity, including replacement of existing facilities between 1975 and 1980.[17] Given the

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[16] *PTm(Steel) analysis.*

[17] *Edgar J. Speer, Chairman, U.S. Steel Corporation, Speech before the Joint Economic Committee, October, 1974.*

severely decreased demand level which has been experienced in the first six months of 1975, however, it is unclear whether this projection of needed capacity will be altered by industry spokesmen in the future.

TECHNOLOGY IMPROVEMENTS ASSOCIATED WITH CAPACITY ADDITIONS

The mid-1950s through the early 1960s were predominantly devoted to the expansion of raw steel capacity. The following decade attended to the modernization and replacement of existing facilities, with particular emphasis on change of furnace type. Attention was also paid to increasing finishing facilities.

The greatest technological improvements since World War II have been the basic oxygen furnace and continuous casting. The basic oxygen furnace (BOF) was a European process introduced in the U.S. in 1955. By 1965 it represented 17.4 percent of total raw steel production and by 1974 had captured 56.0 percent. The basic oxygen furnace, with its shorter production cycle, increased automation, and tighter controls, has essentially replaced open hearth production. In 1950 open hearth represented 89.1 percent of total industry raw steel production. By 1974 its share had been reduced to 24.4 percent.

Continuous casting is the process which has replaced the conventional technique of pouring hot metal into ingot molds before breaking into primary forms such as slabs. The continuous process of casting slabs and billets directly from molten steel cuts the primary forming time and increases the yield substantially. It offers an improved quality of steel and, by minimizing mold changes and other operation adjustments, offers substantial savings per ton for most grades of steel. Currently, continuous casting represents only about 7 percent of domestic steel production, but many sources predict that this level will increase to nearly 30 percent by the mid-1980s.[18]

Another change of importance since World War II has been the introduction on a widespread basis of electric furnaces. Using a 100 percent scrap charge, the electric furnace is the prime "recycler" among steel industry facilities. It was introduced in the U.S. for the first time in 1906; by 1950 it represented 6.2 percent of steelmaking furnace output and by 1974 represented 19.7 percent. Many experts foresee the electric furnace playing an increasing role in production levels as mini-mills and semi-integrated mills expand. This prediction, however, is largely dependent on the assumption that scrap will be available in large quantities and that power costs will not become prohibitive.

Hot rolling, cold rolling, and finishing mill capacity received a substantial share of attention, particularly in the early 1950s. Capital expenditures in rolling mills have included process computers, wider and faster mills, and other quality improvements which offer cost savings as well. The 80-inch strip mill especially has allowed finishing capacity to keep up with maximum levels of raw steel facility utilization.

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[18] *Data Resources, Inc., Steel Forecast Service, Summer 1975*

Future technological advances through the late 1970's and into the 1980's are expected to focus largely on raw material improvement. Much experimentation with the use of nuclear energy in the conversion of iron ore and steel and with a new coking process to conserve scarce matellurgical coal is anticipated.

BUSINESS CYCLES

Steel demand, like demand for all basic materials, is essentially derived from demand for end-market, finished goods. Steel consumption characteristically exhibits more volatile patterns than total GNP because of the industry's dependence on traditionally cyclical demand for durable goods and equipment. Sales and profits of the steel industry are cyclical in nature as well. Annual fluctuations in steel shipments historically have reflected the vigor of the overall economy.

During the years 1946-1957, shipments of finished steel products trended generally upwards, with an overall increase of 64 percent during the period. In the six years that reflected annual increases, the average rate of increase was in the vicinity of 20 percent, while during the five years where declines in shipments occurred the decrease was in the area of 10 percent. The recession of 1954 and major strike periods of steel workers during 1946, 1949, and 1956 caused specific downswings in this overall pattern. However, recovery during the years 1955-1957 was generally quite strong.

A major national recession in 1958 coupled with an unprecedented 116 day strike in 1959 were the catalysts in what was to be a severe four-year slump for the steel industry.

The mid-1960s was a time of strongly accelerated growth in manufacturing and industrial production sectors, and steel shipments experienced strong recovery during these years. Annual growth was in the vicinity of 7 percent per year, and in 1965 shipments exceeded the 90-million tons per year level for the first time, with steel industry earnings correspondingly better than they had been since the early 1950s. This boom period existed despite increasing import penetration and increasing labor costs.

The years 1967 through early 1972 were an era of changing fortunes for the steel industry. Shipments of steel product remained flat on the average. Some respite was experienced in 1968 with a short-term increase due to hedge strike buying; however, this was closely followed in the 1970-1971 worldwide recession period by a decrease of 4 million net tons. Utilization of existing plant capacity was at an all-time low; foreign capacity and foreign imports were increasing at an accelerating rate, and in fact, were quickly absorbing all growth in the domestic market.

This downward spiral of market share halted in 1972 as the general economy strengthened and as, for the first time in modern history, world capacity of steelmaking facilities was not sufficient to meet worldwide demand. The needs for construction equipment, oil production and pipelines, electrical energy equipment, construction, and pollution control equipment in all industries placed such a heavy burden on existing steel supplies that prices for imported goods increased significantly. The U.S. steel industry experienced record high volumes of shipments, full utilization of all existing production capacity, and sharply rising efficiencies in production at these higher operating rates, all leading to the most profitable year in recent history.

As the world economy boomed, so did the domestic steel industry, with such vigor that many steel forecasters predicted that this resurgence would continue through 1975 into the late 1980s. However, the downturn in the overall economy in the second and third quarters of 1975 had been sharply reflected in steel shipments. Current estimates are that year-end totals will show a decrease in shipments somewhere in the magnitude of from 20 to 25 percent from last year's level of 109.5 million net tons. One reason for the decline in shipments has been accelerated usage of inventoried stockpiles by steel users during 1975. By year end, with inventories depleted to minimum levels, it is anticipated that shipments by steel producers should rebound in 1976. The duration of the current downswing in the steel industry will be connected to the health of the general economy if historical patterns are repeated.

LABOR

The American steel industry historically has been a major employer of industrial workers in this country. The absolute number of wage earning steelworkers declined since the end of World War II as mechanized and computerized systems took control of certain operations. However, the industry has consistently employed 2.6 to 3.7 percent of all persons involved in manufacturing during the period.[19] In 1974, the steel industry in the U.S. had approximately 512,000 employees (both hourly and salaried) engaged in the production and sale of iron and steel products. This means almost 4,700 individuals are employed per million tons of steel shipped. This figure is higher in the case of specialty steel products and lower for semi-finished products.

High productivity rates measured in number of man-hours per ton were a key ingredient to the comparative advantage enjoyed by the U.S. over foreign producers of steel until recent years. Exhibit A-15 shows that only in the last three years has Japan outdone the U.S. in productivity ratings. Precise man-hour per ton comparisons of the U.S. and other countries are difficult because of structual differences in the steel industries themselves and in data collection methods. However, it is clear that in the last 20 years the fastest rate of reduction in man-hours required per ton produced has been achieved by the Japanese. The German and French producers are next, followed by the Americans (with a substantially reduced rate of increase). The U.S. advantage in productivity is narrowing quickly.

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[19] *U.S. Department of Commerce, Bureau of Census,* *Statistical Abstract of the U.S.*

American steelworkers' average hourly earnings consistently have been above average for workers in all manufacturing industries. In 1955 their rate was 55 cents above average and in 1960 it was 82 cents. In 1974 steelworkers enjoyed a spread of $1.98 per hour. In a comparison with the top 27 other major industries, the steel industry wage gain of $4.69 per hour during the period 1950-1974 is highest.[20]

These statistics only reflect the hourly earnings portion of steelworkers' compensation. Total employment benefits would include pension, insurance, extended vacation plans, etc. On the average, approximately 40 percent of the cost of manufacturing steel in the U.S. consists of labor costs including fringe benefits.

The three-year cycle on which steel labor contracts historically were negotiated had tremendous impact on the operating flows of the industry. In the steel industry virtually all hourly-rated employees are members of the United Steel Workers of America. Contract negotiations are industry-wide. All of the major producers, representing over 90 percent of the steel industry, are involved directly. If a contract expires without a new contract having been negotiated successfully, a strike may follow. As pointed out in Exhibit A-16, which outlines dates of steel contract negotiations and strike periods, in the years since World War II, production in the U.S. steel industry virtually has come to a standstill on at least five different occasions during periods of general steel strikes. Strikes can result often in near emergency situations throughout the economy. Having learned from experience, as a contract deadline approaches, customers invest heavily in steel products in an effort to stockpile against the threat of a lengthy strike. Demand for steel products fluctuates as a result of this hedge-buying.

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[20] *American Iron & Steel Institute, "Wage Trends in the Iron and Steel Industry."*

The last and most lengthy of the steelworkers strikes occurred in 1959, when the union struck for an unprecendented 116 days. Eighty-eight percent of the U.S. steel industry was shut down by this walkout, and a Taft-Hartley injunction was required to re-open production facilities. The unhappy experience of 1959 substantially altered company/union relations for a number of years. Nevertheless, the union continued to focus its primary concern on wage and fringe benefit packages and on the effect which new technology improvements might have on continued high levels of employment in the industry.

Management-union relationships in the steel industry have taken a substantially different turn due to the successful signing in 1973 of the Experimental Negotiating Agreement (ENA) whereby the union pledged not to strike nationally and to submit contract negotiations to binding arbitration in the case of a stalemate in future bargaining. This contract is also unique in comparison with past agreements in that it has a six-year duration. The hope is that this new form of agreement will eliminate the "peak and valley" pattern of inventory build-up and take-down, which in the past has occurred in every year in which a labor contract expired.

FOREIGN COMPETITION

The history of foreign steel competition in the U.S. market is linked closely to the history of labor negotiations. Until 1959 the U.S. was a significant net exporter of steel products. In 1957 exports were 5.3 million tons and imports were 1.2 million tons. By the end of 1959 a reversal had taken place for the first time in history, as exports were at 1.7 million tons and imports stood at 4.4 million tons. What had occurred during this two-year interim was largely the result of the 116-day strike, when imports flooded into the domestic market to meet the demand which could not be met by domestic producers. Whereas in 1957 imports represented only 1.6 percent of apparent consumption in the U.S., in 1959 the import share had jumped to 6.1 percent.

Buying imported steel to build inventory as a hedge against possible future strikes became a pattern which has been continued for two decades. Experience has shown that as domestic consumers of steel increase their buying of imports during strike uncertainties, this substantially reduces their inhibitions against regularly purchasing foreign steel. Steel industry statistics show that after steel imports rise to abnormally high levels during strike hedge buying, the magnitude of imports rarely has returned to its previous level once labor contracts are settled. Exhibit A-17 plots apparent consumption for the years 1955 through 1974 and shows that portion which is import share above the shipments minus export line. In 1968 imports were 16.7 percent of apparent consumption, and in 1971, another year where strike threatened, the level had risen to 17.9 percent. Between 1966 and 1972, imports effectively captured all the growth in domestic consumption in the U.S.

A second major cause for the increased penetration of steel imports has been the fluctuations in world supply and demand for steel. Immediately following World War II, the U.S. was the primary supplier of steel in the world, since facilities of other major industrial nations had been ravaged during the war. Japan and Western Europe had to substantially rebuild their severely damaged steel industries. Of particular importance is that, in replacing productive facilities, foreign nations utilized only the most modern technologies, which enabled them to make full advantage of advanced production methods. New units were also built to take advantage of economies of scale.

By the early 1960s, Japanese and European steel had expanded capacity to the point that they were ready to export. As the governments of several major steel producing nations overestimated the steel requirements of their own economies, and since the U.S. appeared to be a lucrative market, foreign steel suppliers entered the U.S. market in the early 1960s by offering steel at prices up to 30 percent below the U.S. price. The pricing advantage enjoyed by foreign suppliers in the U.S. market continued from 1959 through 1971. With a substantial majority of foreign facilities operating under government subsidy, foreign pricing schemes allowed the export of steel products at less than full cost.

Both capital costs and operating costs of foreign producers were significantly lower than those experienced by U.S. producers. Of key importance were the low labor costs enjoyed by foreign steelmakers. In 1960 American steel companies paid 6.2 times the Japanese rate for labor and 3.2 times the West German rate. By 1970, wages were rising in foreign nations and the gap in total labor costs as compared with U.S. expenditures for labor was decreasing. The U.S. was spending 2.8 times the Japanese rate and 1.8 times the West German rate.

In 1973, United States employment costs of $76.80 per net ton were still higher than the other four major steel producers. However, West Germany was quite close at $72.83 per net ton. Japan was less than one half the U.S. cost at $35.62 per ton. In addition, between 1955 and 1973, the U.S. cost increased at 3.9 percent per year while Japan increased 1.6 percent per year. Only West Germany's increase of 5.5 percent per year exceeded the United States.

In the late 1950s and early 1960s, the mix of imported products was primarily composed of wire nails, wire rods, barbed wire, and concrete reinforcing bars. That is, the products came substantially from cruder, less sophisticated finishing mills. In 1962 imports in the sheet, strip, and tin plating lines represented only 1.1 percent of the U.S. domestic market for these products.

In the 1960s, however, due to the addition of improved technology and facilities there was a marked change in the trend of product mix of imported goods. Light strip and flat rolled products from imported sources increasingly took over the domestic market. By 1971 imports of sheet, strip, and tin plated products represented 16.8 percent of the domestic market.

In 1968, as steel customers inventoried large stockpiles of steel products against the threat of a labor strike, import penetration rose to an unparalleled 18 million tons, an increase of 60 percent over the previous year. Domestic suppliers started to take what were, for this industry, drastic steps to fight the increased import level. In an attempt to induce stockpiling of domestic goods rather than imports, price cuts of up to 20-25 percent below the published price per ton were offered, as well as reduced rates on warehousing facilities, transportation, and lengthened payment schedules. Major domestic producers historically had held price and allowed volume to suffer in the face of foreign government support of what they called "unfairly priced imports." These price discounting practices, which became prevalent in the late 1960s, were a significant deviation from the standard practice of strictly maintaining quoted list prices.

It is not surprising that the rising level of imports throughout the 1960s gave rise to a movement for more formal protection through governmental channels. Beginning in 1966, hearings were held in the House Ways and Means Committee and the Senate Committee on Finance, arguing the pros and cons of quotas, tariffs, and other protectionist measures. By late 1967, substantial sentiment against the imposition of tariffs had developed. A major argument was that the $30 billion U.S. export market would be subject to retaliation if a steel tariff were imposed.

In the summer of 1968 it was the foreign producers, specifically the Germans and the Japanese, who took the initiative on this issue. Based on the condition that all Congressional hearings stop with respect to tariffs and quotas, they suggested entering into a Voluntary Restraint Agreement, which would be in effect for a three-year period and which would attempt to set tonnage levels and import growth rates. By late December, 1968, letters of intent were exchanged between the U.S. Secretary of State, the Japanese chairman of the Japanese Iron and Steel Export Association, and representatives of the European Community of Steel Companies. Loosely worded, the Agreement established 14 million net tons as a total volume of imports which would be allowable in the three-year period. The Japanese and the E.C.S.C. were each allowed 41 percent of the total, and the remaining foreign producers were allowed 18 percent. The growth rate in imports was limited to 5 percent each year.

The result of the Agreement was a decrease in import levels of 16 percent between 1969 and 1971. However, while import tonnage decreased, there was virtually no change in revenue impact. Foreign producers shipped an increasing volume of specialty steels, especially cold sheets and tool steel products of higher grade alloys and stainless steel. These products sell for up to seven times the value of an equivalent tonnage of carbon steel.

In 1971 the Agreement was rendered virtually ineffective as imports jumped to a record high of 18.3 million net tons. Worldwide demand suffered from general recession conditions, and European and Japanese producers generally strove to export to the U.S. market to maintain production volumes during the slump period. In August of 1971 President Nixon instituted a 10 percent import surcharge. Foreign producers claimed that this was a violation of the Agreement. U.S. customers, once again, fearful of possible strike activity, sought supplies of steel for inventory purposes from whatever source available, and imports flooded the market.

In mid-1971 efforts were made to negotiate a new Voluntary Restraint Agreement which would rectify problems which had arisen under the first Agreement. The U.S. State Department was insistent that measures be taken specifically to limit specialty steel imports.

The resulting signed letters of agreement allocated tonnage limits on stainless and other high alloy products representing approximately an initial 27 percent reduction in allowable imports in these categories, with some small growth permitted in later years. The Japanese accord also provided geographic distribution limitations so that not more than one-third of its shipments would go to U.S. Pacific ports.

In the three years following the signing of this Agreement, import levels decreased. However, it is generally agreed that the primary reason for this was not the Voluntary Restraint Agreement, but rather the surge in world demand for steel which characterized the period. World supplies of steel products were in great demand, and foreign producers found more lucrative markets at home and nearer to home than the U.S. In addition, with the signing of the New Economic Policy in August, 1971, the U.S dollar was devalued and allowed to float in the world market. This signalled a significant improvement in the competitive position of U.S. producers.

The years 1972 to 1974 also were a time of runaway inflation worldwide. For the first time raw material costs and labor costs were catching up with foreign producers. By early 1973, as a result of all the above-mentioned occurrences, foreign suppliers were offering steel at almost twice the price offered by domestic producers in the U.S. market. No longer was the price advantage held tightly in the hands of foreign manufacturers.

The future of import penetration in the U.S. is somewhat unclear. It is estimated that, on a relative basis, the percentage of imports will decline, although there is substantial disagreement over whether the impact will fall much below 13 percent of domestic apparent consumption. The future effectiveness of Voluntary Restraint Agreements is also uncertain. Japan has announced some unwillingness to extend the 1971 agreement. Furthermore, nations other than Western Europe and Japan, such as Sweden, have become substantial exporters of steel to the U.S. and are not covered by these agreements.

PRICING POLICY IN THE STEEL INDUSTRY

In examining steel prices, real and nominal prices must be differentiated. Nominal prices are the observed prices in the market. Real prices are derived from nominal prices through adjustment for inflation. Thus real prices may be decreasing despite increases in nominal prices if the rate of inflation within the economy exceeds the rate of increase in nominal prices. For example, nominal steel prices increased from $162.13 per ton in 1965 to $212.80 per ton in 1973, a 3.5 percent annual increase. The entire economy experienced a rate of inflation of 6.9 percent during the same period. Thus real prices (stated in constant 1965 dollars) decreased from $152.13 per ton to $125.21 per ton.

Considerable effort has been expended by economic researchers and industry practitioners attempting to fit the observed pricing behavior of the steel industry into a theoretical construct. However, no formulation which is clearly representative has emerged. Casual observers might expect firms to decrease prices in order to increase shipment volume or to maintain their volume during a general industry decline. Such behavior is based upon relatively high price elasticity. Many other observers feel that steel has a low price elasticity in comparison to the income elasticity so that a contracyclical pricing policy is followed.[21] That is, the steel industry may tend to increase prices during periods of reduced demand. Similarly, real steel prices may be decreased during periods of economic expansion when demand for steel is high. Such a policy tends to stabilize returns on equity. A description of this behavior and the theoretical basis can be found in "Economic Factors Affecting Pricing Decisions" by J. Fred Weston and Edward Rice.[22]

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[21] *Council on Wage and Price Stability, A Study of Steel Prices, Staff Report, July 1975.*

[22] *Monograph, Graduate School of Management, U.C.L.A.*

In the early 1960's, steel price increases were met with strong Congressional and Presidential opposition and ultimately to a basic change in the industry's pricing structure. In October 1961, President Kennedy wrote a letter to the heads of 12 major steel companies, suggesting that major producers could maintain prices at current levels and still absorb wage increases without injury to their profit positions. In 1961, however, U.S. Steel Company shipments plummeted and the company suffered a 25 to 35 percent drop in profits. Believing a price increase was the only available method of returning the higher levels of return which were badly needed to attract capital for its modernization programs, in April 1962, U.S. Steel announced a $6 per ton price increase, based on increased cost. The reaction in the White House was violent, particularly since, true to traditional patterns, other major steel companies announced price hikes following U.S. Steel's lead. In addition to verbal chastisement, the administration instituted a number of antitrust investigations. The result was that, by April 13, five major steel companies had withdrawn their increases. Bethlehem Steel, second in volume only to U.S. Steel, soon withdrew its increase. Finally, the U.S. Steel price announcement was cancelled, and with this rollback, a period in the history of domestic steel pricing was ended. Since 1962, prices have been raised on a selective product basis, rather than across the board, and even then there normally has been no more than one price increase per year on a particular product.

The second pressure which came to bear on the domestic price structure, and which would severely constrain prices, was foreign imports. In the early 1960's, foreign steel was often available in the U.S. market at up to 30 percent below the domestic price level. This was a force which the existing pricing system had not encountered. In response, U.S. producers maintained prices essentially constant, thus reducing their profit margins as labor and all other costs continued to increase throughout the decade.

The years 1969 through 1971 were difficult ones for the steel industry due to recession pressures, heavy imports, and the unrest associated with steelworker contract negotiations. With the threat of increased import penetration diminished by the First Voluntary Restraint Agreement, prices were raised in an effort to increase profit margins. However, rates of return in the 1970-1971 period were at the lowest level since World War II. The industry entered the subsequent three-year period of wage and price controls in a particularly depressed state.

From August 1971 to late 1973, steel prices were strictly held down by wage and price control. Other industrial sectors on which the steel industry is heavily dependent--e.g., coal and scrap markets--were not subject to controls. During the era of controls, coal, zinc, and fuel oil increased in the vicinity of 125 to 200 percent. The resulting cost-price relationship squeezed steel industry profits acutely. By December 1973, at Inland Steel, costs had outrun price increases allowed by 3 to 1. Over the industry, on average, costs had increased 28 percent, while price increases were in the vicinity of 15 percent. In December 1973, the Cost of Living Council held hearings with representatives of the steel industry. The cost pass-through petition specifically was adopted to offset the spiraling price of scrap. Price increases which had been petitioned for nine months earlier were allowed. From December 1973 to the end of the control period in August 1974, prices increased 39 percent, whereas during the entire August 1971 to August 1974 period, prices had increased only 47 percent. Overall, during the control period era, millions of dollars of costs were unrecovered by steel producers.

As controls were lifted in August 1974, demand was soaring, and domestic supplies together with imports were insufficient to meet customer needs. The theory of contracyclical pricing behavior would indicate that with such increasing volume, prices would not be increased and might even be decreased. However, margins had been eroded so much by increasing costs that price increases were necessary to achieve desired profitability even at maximum volumes. Remembering the unhappy events of 1962, steel producers cautiously raised prices in small steps over the following months, rather than in one large across-the-board jump. Restrained price increases were apparently a correct choice. Little adverse public reaction was experienced, and between April and December of 1974, prices increased 30 percent, bringing welcome profit levels to U.S. steel producers. In 1973 the shipment boom earned the industry a 9.3 percent return, a level which had not been experienced since the period of strong demand in 1964 and 1965, and in 1974 return on equity soared to 17.1 percent. This level of return never had been attained by the steel industry, even during the strong growth period in the late 1950s. Even at this high point, the steel industry return was only slightly above the average of 15.4 percent for all manufacturing.

RELATIONS WITH GOVERNMENT

The federal government has remained substantially outside of the management of the steel industry, though occasionally has intervened in an attempt to influence industry decisions. As an example, during the Korean War era, the Administration attempted to force a negotiated wage settlement prior to an impending labor strike deadline. This controversial step was finally arbitrated in the Supreme Court, where the actions were ruled unconstitutional. The government does, however, exert substantial influence through its stance on business combinations.

The anti-merger posture of the U.S. government is illustrative of the many differences in attitude between the U.S. government and foreign governments concerning the government's role in shaping the structure of domestic steel production. The attitude of most free-world governments has been pro-merger in order to achieve economies of scale. This position was evidenced as early as 1948 when seven companies located in Germany and France merged. This combination allowed the companies to utilize a very efficient, new 80-inch hot strip mill, which individually none of these companies could have supported. In 1967 in Great Britain, consolidation was accomplished when 14 steel companies were nationalized, combining 90 percent of the nation's raw steel capacity. The pro-merger posture was exhibited in Japan in 1969 with the joining of Yawata and Fuji Steel Companies, a merger comparable in terms of their share of national productive capacity to a merger between U.S. Steel and Bethlehem Steel in the United States.

Foreign governments have assumed a supportive role in the development of their steel industries in other ways. In 1974, 70 percent of world steel output was from facilities which were owned, operated, or subsidized by government. Foreign government assistance to steelmakers ranges from offering very low interest rates on debt to supplying non-tariff protection against imports. The Japanese go so far as to coordinate central planning to avoid duplication of facilities, and in fact, allocate capacity expansion among companies and mills. In the 1970-1971 worldwide recession period, a "depression cartel" was organized in Japan to apportion reduction in output among suppliers when production was curtailed. In contrast, in the United States, financial assistance is more limited and generally takes the form of tax credits, state revenue bonds, accelerated depreciation schedules, and other allowances in accounting practices available to all industrial firms.

In recent years the steel industry has lobbied for legislative support of its efforts to build capacity. Among the suggestions are a permanent investment tax credit and liberal depreciation schedules, which would allow a truer capital cost recovery based on plant and equipment investment. The industry has also suggested amendments to the tax laws which would give immediate full-cost write-off of pollution control expenditures on both old and new facilities.[23]

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[23] *American Iron and Steel Institute, Steel Industry Economics and Federal Income Tax Policy, June 1975, p. 39.*

Exhibit A-1

RANKING OF MAJOR STEEL COMPANIES BY PRODUCTION LEVELS
1940-1974
(millions of net tons)

Rank	1940	1945	1950	1955	1960	1965	1970	1974
1	U.S. Steel	U.S. Steel	U.S. Steel	U.S. Steel	U.S. Steel	U.S. Steel	U.S. Steel	U.S. Steel
2	Bethlehem	Bethlehem	Bethlehem	Bethlehem	Bethlehem	Bethlehem	Bethlehem	Bethlehem
3	Republic	Republic	Republic	Republic	Republic	Republic	Armco	Armco
4	Jones & Laughlin	Jones & Laughlin	Jones & Laughlin	Jones & Laughlin	Jones & Laughlin	National Steel	Republic	Republic
5	National Steel	Youngstown Sheet	National Steel	National Steel	National Steel	Jones & Laughlin	National Steel	National Steel
6	Youngstown Sheet	National Steel	Armco	Youngstown Sheet	Armco	Armco	Inland	Inland
7	Inland	Inland	Youngstown Sheet	Inland	Youngstown Sheet	Inland	Jones & Laughlin	Jones & Laughlin
8	American Rolling	American Rolling	Inland	Armco	Inland	Youngstown Sheet	Youngstown Sheet	Youngstown Sheet
9	Wheeling Pittsburgh	Sharon	Wheeling Pittsburgh	CF&I	Kaiser	McLouth	Allegheny Ludlum	Wheeling Pittsburgh
10	CF&I	Wheeling Pittsburgh	CF&I	Wheeling Pittsburgh	Colorado Fuel	Kaiser	Wheeling Pittsburgh	Allegheny Ludlum

Source: Iron Age Magazine, Annual Steel Industry Financial Analysis; and Steel Magazine

Exhibit A-2

PERCENTAGE OF SHIPMENTS CONTRIBUTED BY LEADING STEEL COMPANIES

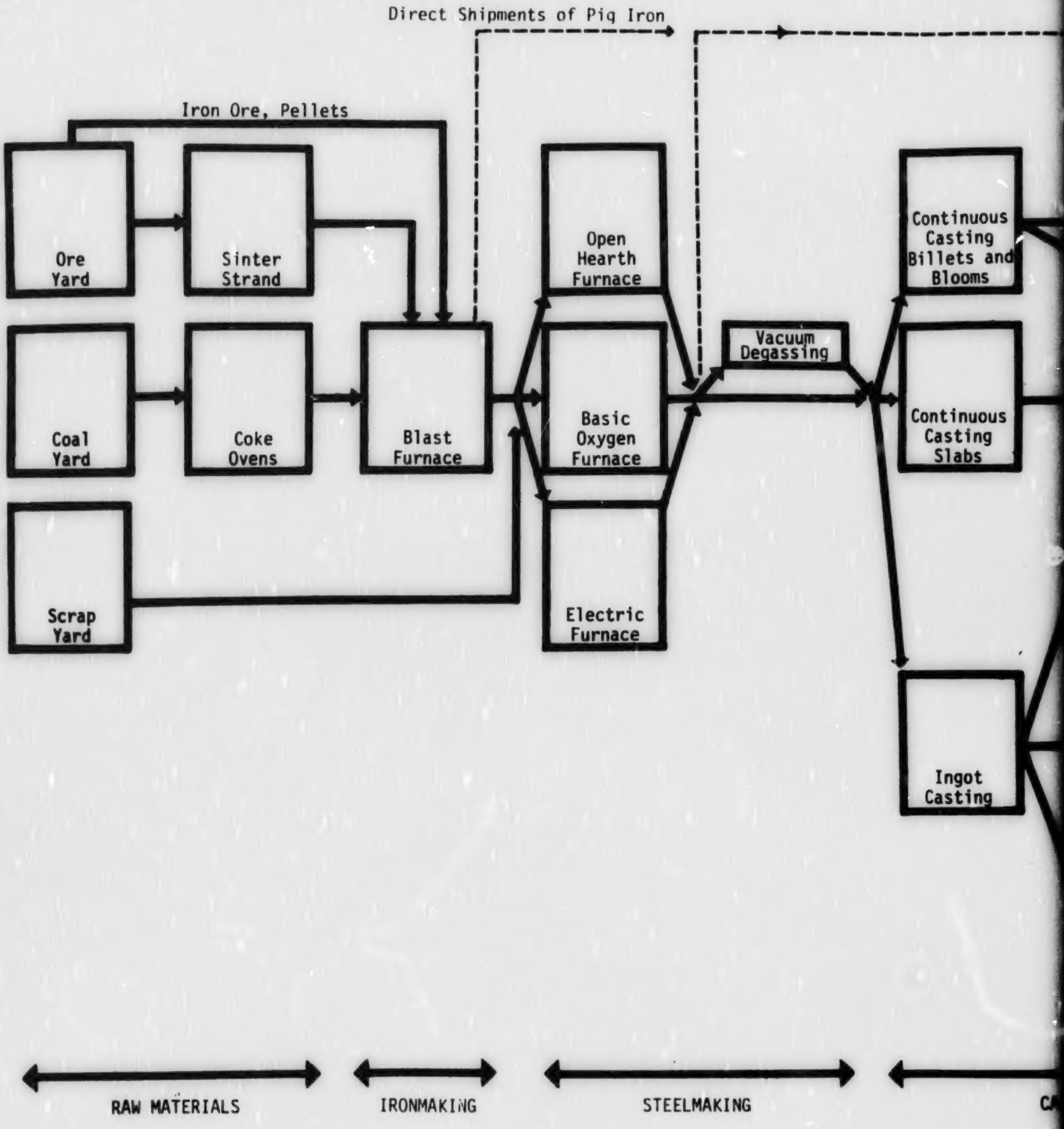
1950-1974

Companies	1950	1955	1960	1965	1970	1974
Top 4	64	64	59	54	51	51
Top 10	80	81	84	78	76	78
Top 15	84	86	92	84	82	84
Top 20	88	87	96	87	85	88

Source: Iron Age Magazine, Annual Statistical Financial Report; and Steel Magazine

Exhibit A-3

SCHEMATIC OF STEEL PRODUCTION PRO


Direct Shipments of Pig Iron
Iron Ore, Pellets
Ore Yard
Sinter Strand
Coal Yard
Coke Ovens
Blast Furnace
Scrap Yard
Open Hearth Furnace
Basic Oxygen Furnace
Electric Furnace
Vacuum Degassing
Continuous Casting Billets and Blooms
Continuous Casting Slabs
Ingot Casting
RAW MATERIALS
IRONMAKING
STEELMAKING
CA

ON PROCESS

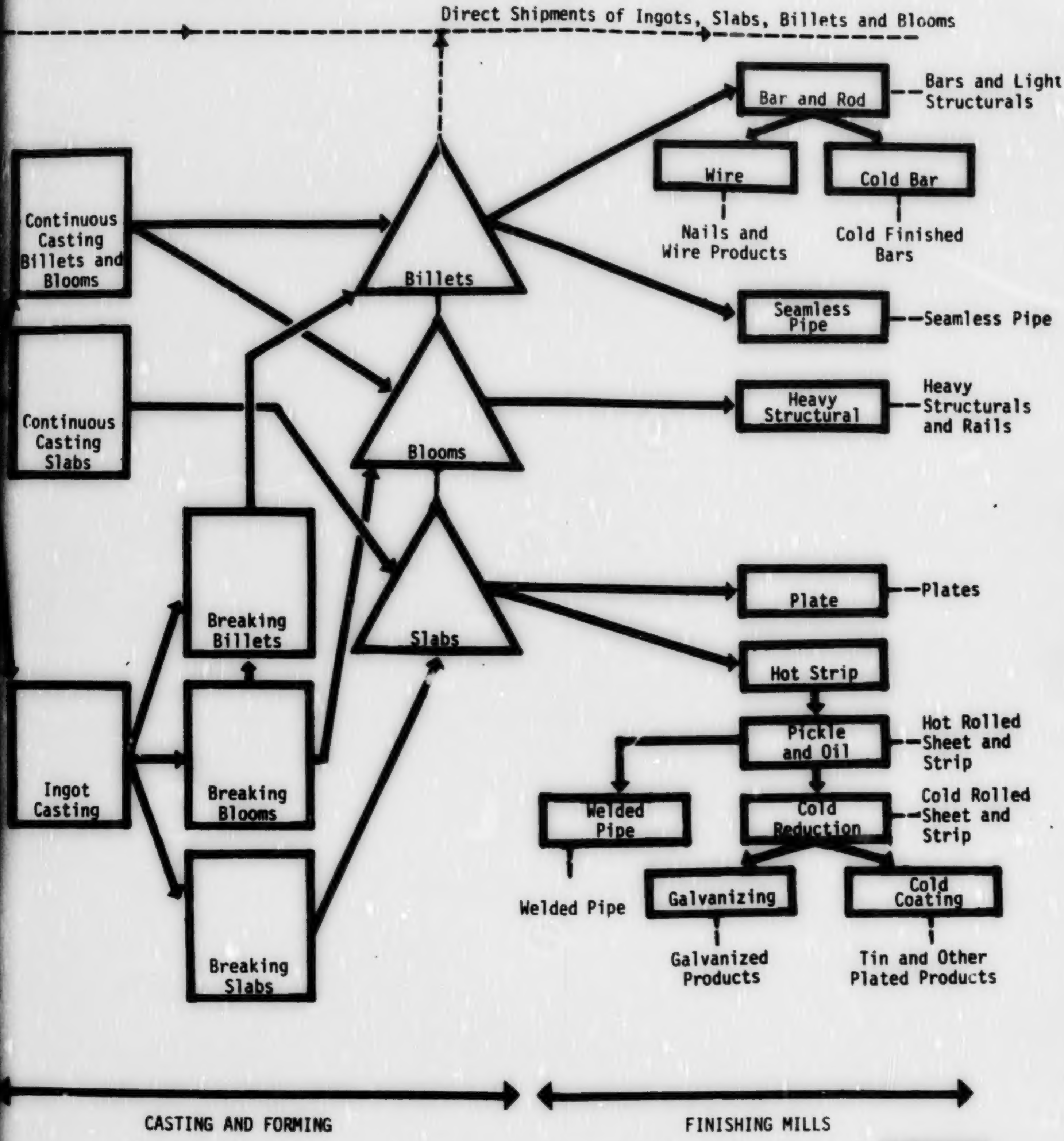

Direct Shipments of Ingots, Slabs, Billets and Blooms
Continuous Casting Billets and Blooms
Continuous Casting Slabs
Ingot Casting
Breaking Billets
Breaking Blooms
Breaking Slabs
Billets
Blooms
Slabs
Bar and Rod
Bars and Light Structurals
Wire
Nails and Wire Products
Cold Bar
Cold Finished Bars
Seamless Pipe
Seamless Pipe
Heavy Structural
Heavy Structurals and Rails
Plate
Plates
Hot Strip
Pickle and Oil
Hot Rolled Sheet and Strip
Welded Pipe
Welded Pipe
Cold Reduction
Cold Rolled Sheet and Strip
Galvanizing
Galvanized Products
Cold Coating
Tin and Other Plated Products
CASTING AND FORMING
FINISHING MILLS

Exhibit A-4

PLANT AGE BREAKDOWN BY PROCESS
1972

Process	Number of Plants			
	Pre-1945	1946-1954	1955-1972	Total
Raw Materials				
Ore Yard	38	11	3	52
Coal Yard	24	17	4	45
Scrap Yard	31	25	30	86
Sintering	10	13	11	34
Coke Oven	41	44	42	127
Ironmaking				
Blast Furnace	120	42	11	173
Steelmaking				
Open Hearth	0	20	3	23
Basic Oxygen Furnace	0	0	32	32
Electric Furnace	7	13	33	53
Vacuum Degassing	0	0		
Forming/Casting				
Ingot Casting	23	19	35	77
Continuous Casting--Billets	0	0	16	16
Continuous Casting--Slabs	0	0	8	8
Finishing				
Primary Breakdown--Blooms	17	6	3	26
Primary Breakdown--Billets	22	14	7	43
Primary Breakdown--Slabs	15	11	12	38
Heavy Structurals	0	15	0	15
Bar Mill	30	12	22	64
Cold Finished Bars	0	0		
Wire Mill	0	4	6	10
Seamless Pipe	0	7	0	7
Hot Strip Mill	10	17	14	41
Pickling	13	18	17	48
Welded Pipe	0	12	0	12
Cold Reduction	13	24	17	54
Galvanizing	0	10	7	17
Tin Plating	0	6	4	10
Plate Mill	0	10	5	15
Ancillary Facilities				

Exhibit A-5

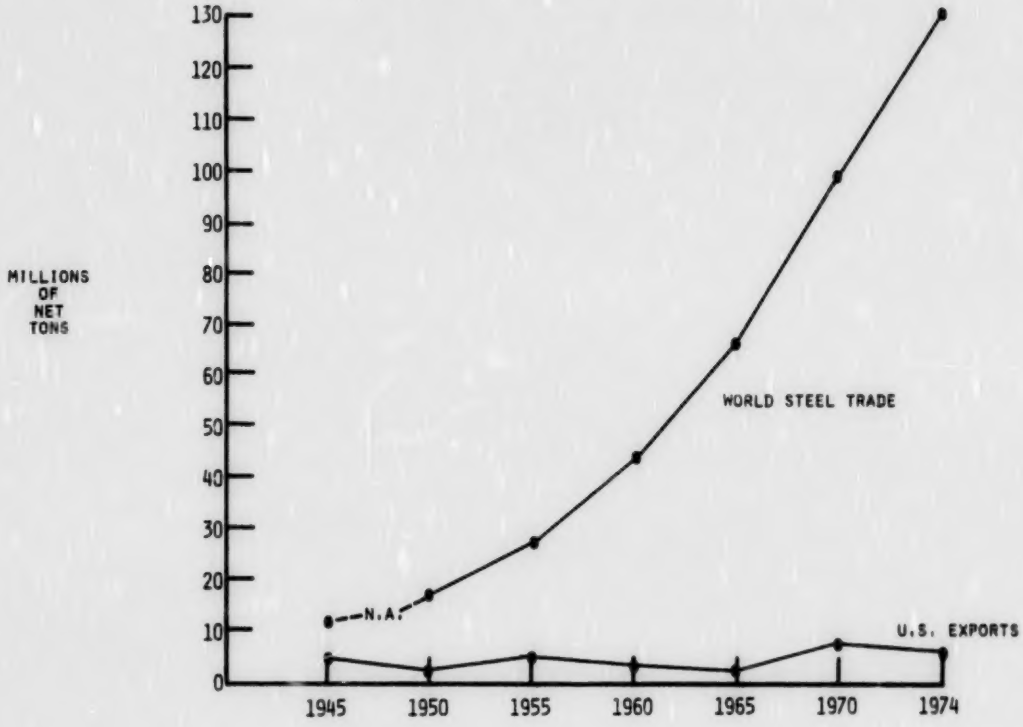
PLANT SIZE BREAKDOWN BY PROCESS
1972
(capacity in millions of tons)

Process	Small			Medium			Large			Total		
	Pre-1945	Post-1945	Total	Pre-1945	Post-1945	Total	Pre-1945	Post-1945	Total	Pre-1945	Post-1945	Total
Raw Materials												
Ore Yard	19.38	4.43	23.81	34.91	15.78	50.69	87.49	40.52	128.01	141.78	60.73	202.51
Coal Yard	4.78	2.72	7.50	8.87	7.67	16.54	27.74	33.87	61.61	41.39	44.26	85.65
Scrap Yard	1.44	4.19	6.13	7.86	11.68	19.54	17.84	31.76	49.60	27.64	47.63	75.27
Sintering	4.30	5.13	10.43	0	0	0	6.39	30.04	6.43	10.69	36.17	46.86
Coke Oven	3.33	6.59	9.92	5.83	6.18	12.01	8.17	29.42	37.59	17.33	42.19	59.52
Ironmaking												
Blast Furnace	19.93	2.41	22.34	33.54	5.92	39.46	19.12	38.57	57.69	72.59	46.90	119.49
Steelmaking												
Open Hearth	0	15.22	15.22	0	0	0	0	33.88	33.88	0	49.10	49.10
Basic Oxygen Furnace	0	25.73	25.73	0	0	0	0	60.54	60.54	0	86.27	86.27
Electric Furnace	0.48	1.39	1.87	0.90	9.53	10.43	0	13.51	13.51	1.38	24.43	25.81
Vacuum Degassing	0	0	0	0	0	0	0	39.07	39.07	0	39.07	39.07
Forming/Casting												
Ingot Casting	2.60	4.15	6.75	6.40	23.22	29.62	35.17	79.09	114.26	44.17	106.46	
Continuous Casting--Billets	0	1.54	1.54	0	0	0	0	4.20	4.20	0	5.74	5.74
Continuous Casting--Slabs	0	1.71	1.71	0	0	0	0	6.30	6.30	0	8.01	8.01
Finishing												
Primary Breakdown--Blooms	4.51	0	4.51	0	0	0	19.24	7.30	26.54	23.75	7.30	31.05
Primary Breakdown--Billets	1.33	1.13	2.46	3.69	3.69	7.38	15.49	18.93	34.42	20.51	23.75	44.26
Primary Breakdown--Slabs	7.45	2.09	9.54	9.39	21.17	30.56	14.52	25.53	40.05	31.36	48.79	80.15
Heavy Structurals	0	6.69	6.69	0	0	0	0	8.69	8.69	0	15.38	15.38
Bar Mill	1.23	4.26	5.49	2.89	3.91	6.80	11.29	13.19	24.48	15.41	21.36	36.77
Cold Finished Bars	0	0	0	0	0	0	0	3.41	3.41	0	3.41	3.41
Wire Mill	0	0.94	0.94	0	0	0	0	1.90	1.90	0	2.84	2.84
Seamless Pipe	0	1.05	1.05	0	0	0	0	2.64	2.64	0	3.69	3.69
Hot Strip Mill	0.98	5.33	6.31	7.26	18.21	25.47	14.90	39.06	53.96	23.14	62.60	85.74
Pickling	1.63	3.89	5.52	3.37	13.10	16.47	16.03	34.53	50.56	21.03	51.52	72.55
Welded Pipe	0	0.93	0.93	0	0	0	0	3.81	3.81	0	4.74	4.74
Cold Reduction	1.08	2.73	3.81	2.81	16.23	19.04	12.38	12.38	24.76	16.27	31.34	47.61
Galvanizing	*	2.53	2.53	*	0	0	*	5.03	5.03	*	7.56	7.56
Tin Plating	0	2.42	2.42	0	0	0	0	4.40	4.40	0	6.82	6.82
Plate Mill	0	4.67	4.67	0	0	0	0	8.10	8.10	0	12.77	12.77
Ancillary Facilities	0	0	0	0	0	0	0	0	0	0	0	0

*Data given for Region 1 only--inclusive of all pre-1972 data

EXHIBIT A-[illegible]

U.S. EXPORTS--SHARE OF WORLD STEEL TRADE
1945 - 1974
(MILLIONS OF NET TONS)

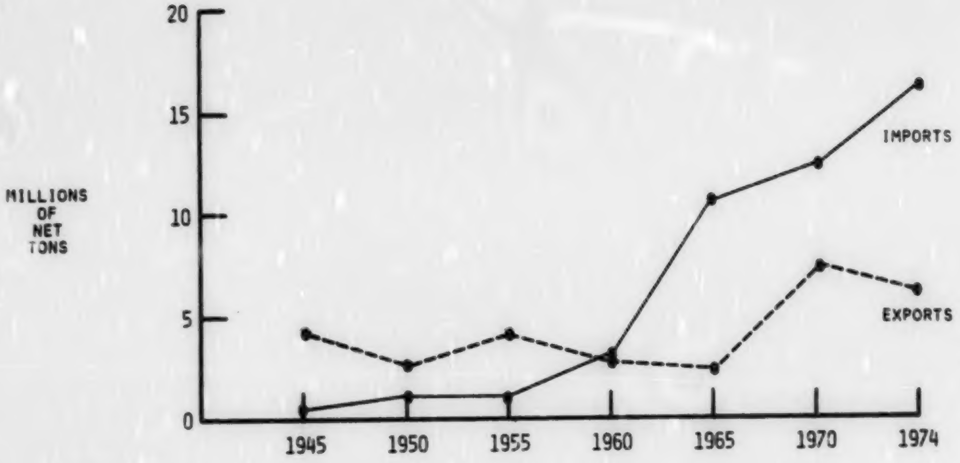


N.A. = NOT AVAILABLE

SOURCE: AISI, STEEL INDUSTRY AND FEDERAL INCOME TAX POLICY, JUNE 1975, P. 46.
UNITED NATIONS SECRETARY OF ECONOMIC COMMITTEE FOR EUROPE, STATISTICS OF WORLD TRADE IN STEEL, 1913-1959, GENEVA, 1967.

EXHIBIT A-7

U.S. IMPORTS AND EXPORTS OF STEEL
1945 - 1974
(MILLIONS OF NET TONS)



SOURCE: AISI, ANNUAL STATISTICAL REPORT

Exhibit A-8

RANKING OF MAJOR RAW STEEL PRODUCING COUNTRIES
1945-1974

Rank	1945	1950	1955	1960	1965	1970	1974
1	U.S.A.	U.S.A.	U.S.A.	U.S.A.	U.S.A.	U.S.A.	U.S.S.R.
2	U.S.S.R.	U.S.S.R.	U.S.S.R.	U.S.S.R.	U.S.S.R.	U.S.S.R.	U.S.A.
3	United Kingdom	United Kingdom	West Germany	West Germany	Japan	Japan	Japan
4	Canada	West Germany	United Kingdom	United Kingdom	West Germany	West Germany	West Germany
5	Japan	France	France	Japan	United Kingdom	United Kingdom	France
6	France	Japan	Japan	China	France	France	China
7	West Germany	Belgium	Belgium	France	Belgium	Belgium	Belgium
8	India	Canada	Italy	Belgium	Italy	China	United Kingdom
9	Australia	Czechoslovakia	Czechoslovakia	Italy	China	Italy	Poland
10	Sweden	Poland	Poland	Czechoslovakia	Canada	Poland	Czechoslovakia

Source: International Iron and Steel Institute, World Steel Trade

Exhibit A-9

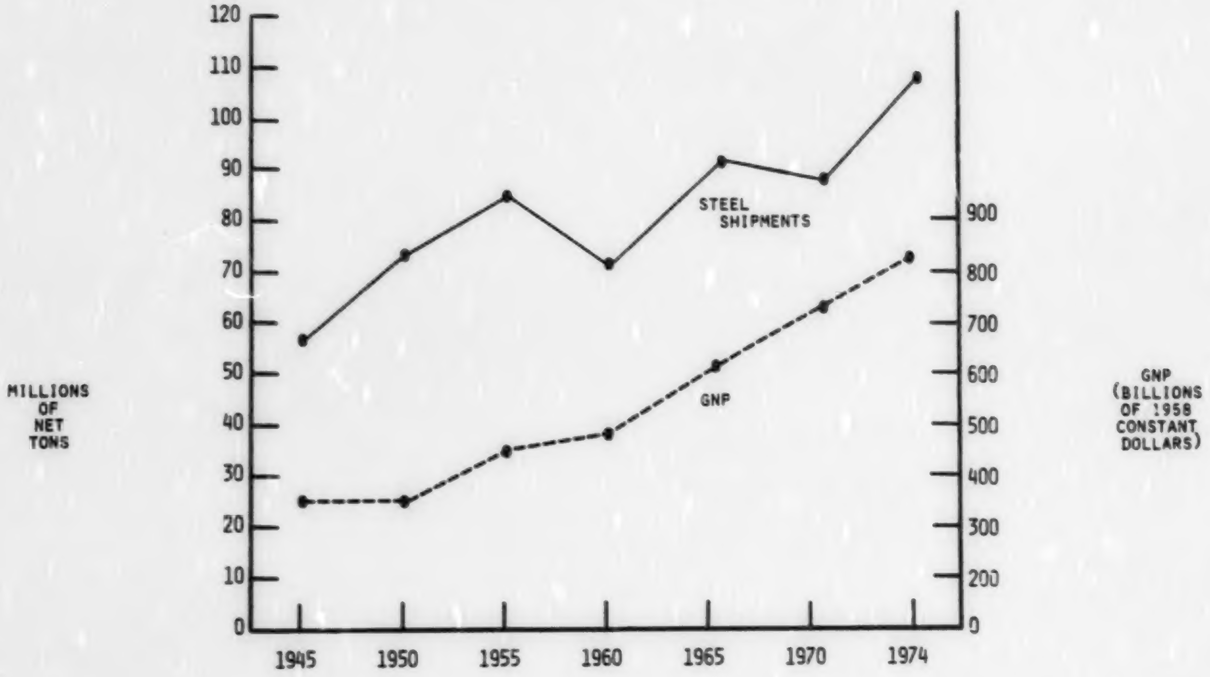
WORLD RAW STEEL PRODUCTION BY COUNTRY
1945-1974
(millions of net tons)

	1945	1950	1955	1960	1965	1970	1975
U.S.A.	79.7	96.8	117.0	99.3	131.5	131.5	145.7
U.S.S.R.	13.8	30.4	50.3	72.0	100.3	127.7	150.2
West Germany	1.7	13.4	23.5	37.6	40.5	49.6	58.7
United Kingdom	13.2	18.3	22.3	27.2	30.3	30.7	24.8
Japan	2.3	5.3	10.4	24.4	45.4	102.9	129.1
China	-	-	-	20.3	13.2	19.2	29.8
France	1.8	9.5	13.9	19.1	21.6	26.2	29.8
Belgium	-	4.2	6.5	12.4	15.2	19.9	25.0
Italy	-	-	5.9	9.1	14.0	19.0	-
Czechoslovakia	-	3.2	5.0	7.5	-	-	15.0
Total World	125.4	211.2	297.3	381.6	503.1	654.2	782.8
U.S.A. Share	63.6%	45.8%	39.4%	26.0%	26.1%	20.1%	18.6%

Source: International Iron and Steel Institute, World Steel Trade

Exhibit A-10

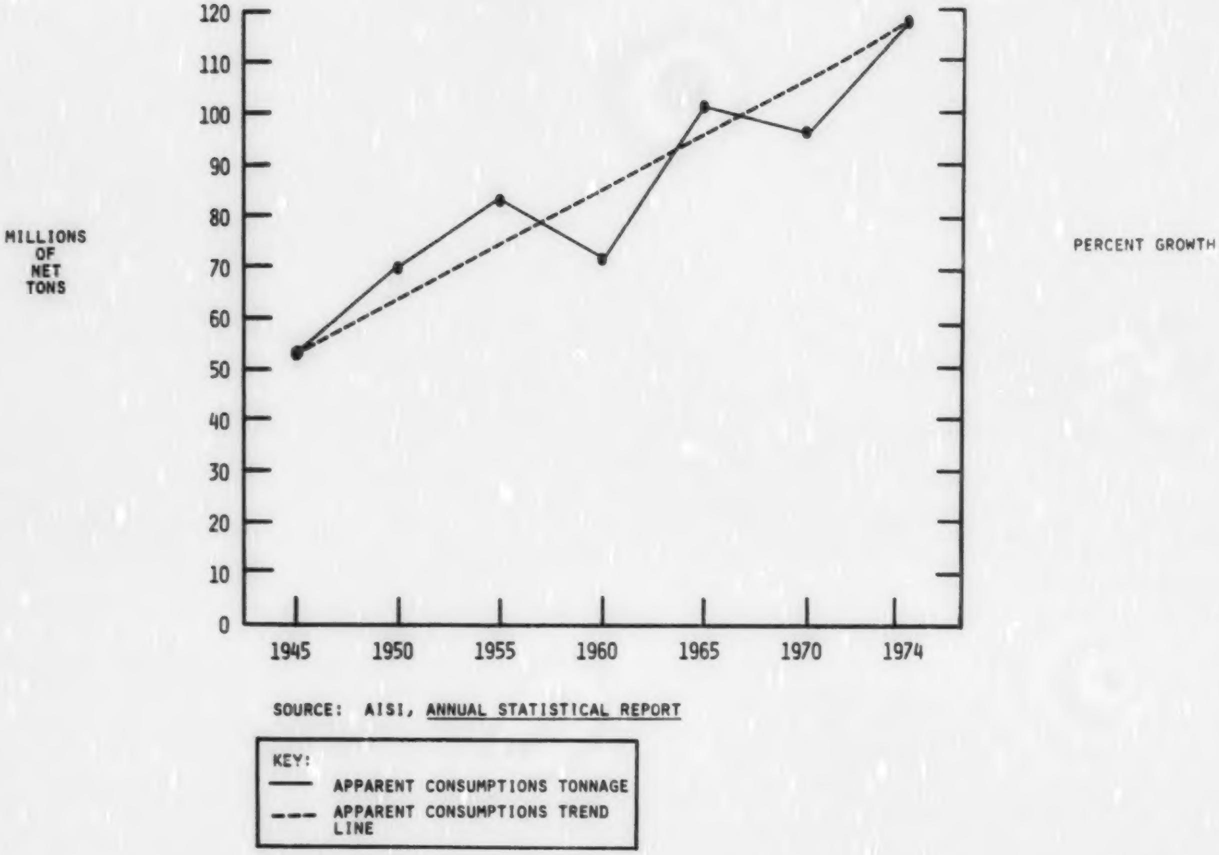
GROWTH OF U.S. STEEL SHIPMENTS CLOSELY TRACKS GROSS NATIONAL PRODUCT
1945 - 1974



SOURCE: AISI, ANNUAL STATISTICAL REPORT;
U.S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS, CURRENT INDUSTRIAL REPORTS, STEEL MILL PRODUCTS, SERIES MA33B

EXHIBIT A-11

GROWTH OF APPARENT CONSUMPTION OF STEEL IN THE UNITED STATES
1945 - 1974
(MILLIONS OF NET TONS)



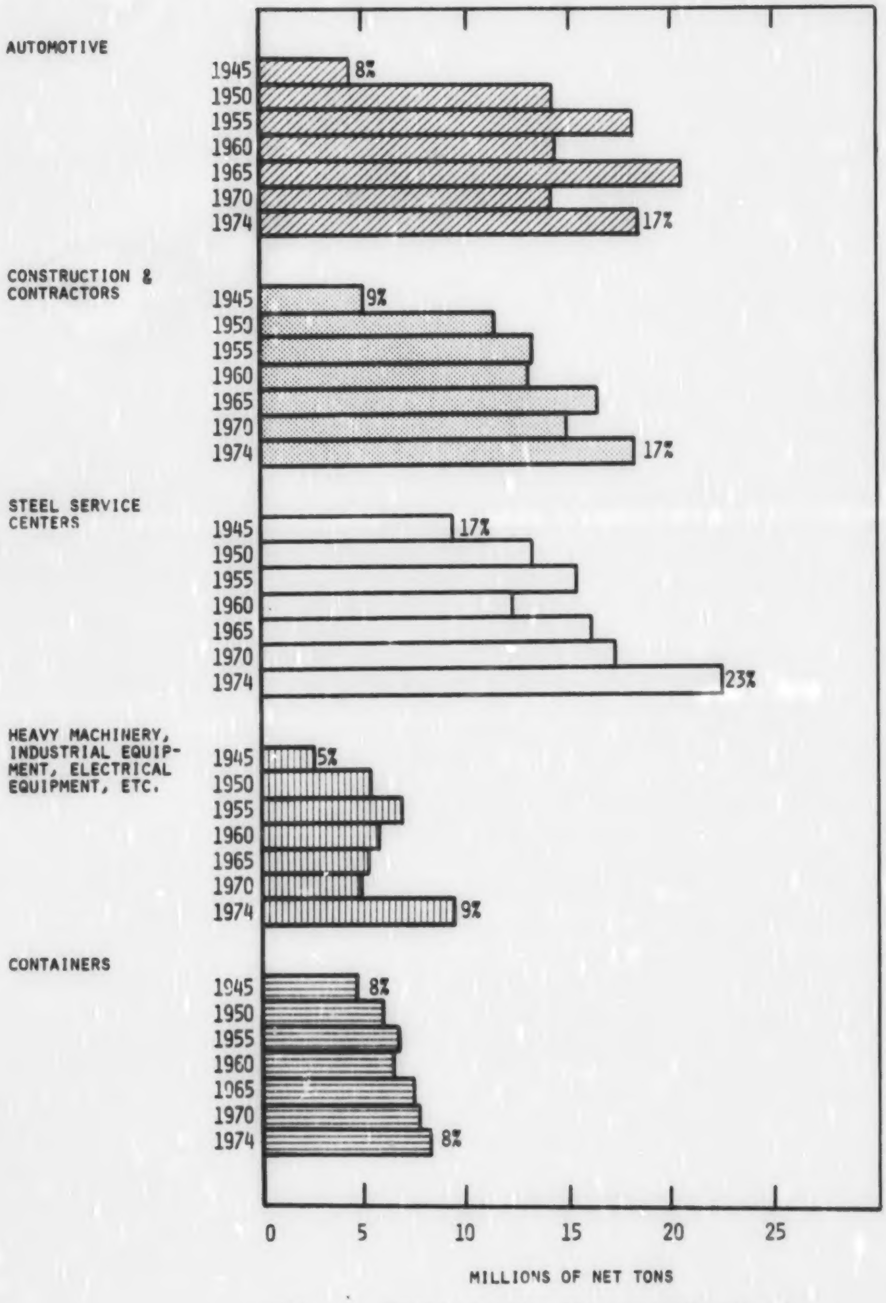
SOURCE: AISI, ANNUAL STATISTICAL REPORT

Exhibit A-12

MAJOR MARKETS FOR STEEL

1945 - 1974

(MILLIONS OF NET TONS)

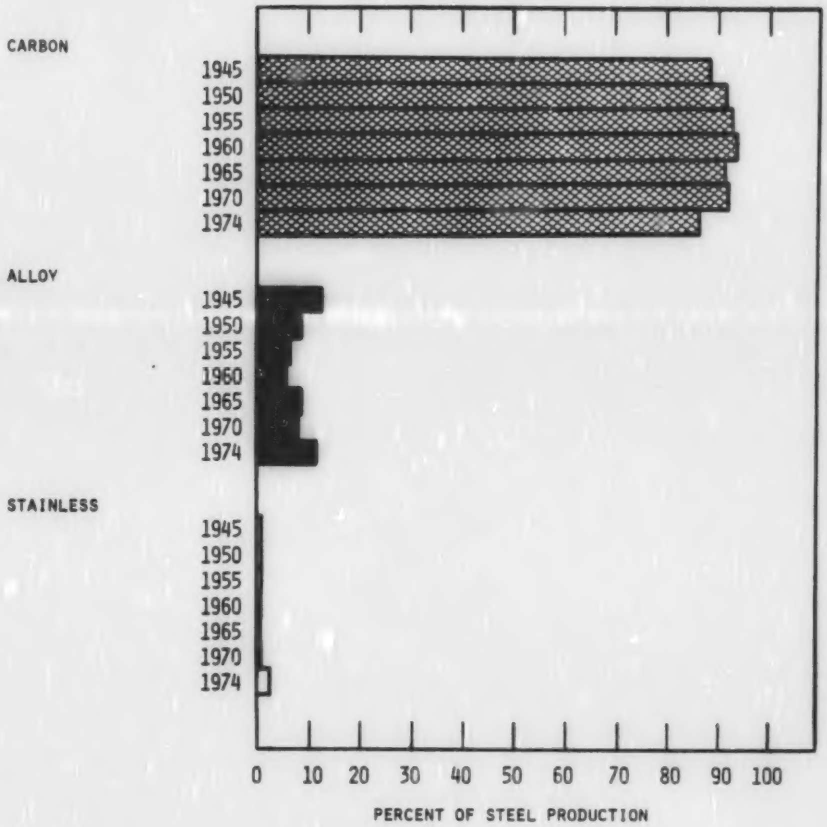


NOTE: % = PERCENT OF TOTAL STEEL SHIPMENTS FOR YEAR

SOURCE: AISI, ANNUAL STATISTICAL REPORT

EXHIBIT A-13

RELATIVE CONTRIBUTION OF EACH GRADE OF STEEL TO STEEL SHIPMENTS
1945 - 1974
(PERCENT OF STEEL PRODUCTION)



SOURCE: AISI, ANNUAL STATISTICAL REPORT

Exhibit A-14

STEEL SHIPMENTS BY PRODUCT CATEGORY
1945-1974
(as percent of total)

Product Category	1945	1950	1955	1960	1965	1970	1972	1974
Direct Shipments of Slabs, Ingots, Billets, Blooms	8.7	4.3	4.0	2.5	3.3	6.3	3.3	3.3
Heavy Structurals and Rails	13.2	10.5	8.6	9.2	9.0	8.4	7.9	8.2
Nails and Wire Products	5.7	6.3	5.1	4.2	3.8	3.3	3.2	2.9
Bars and Light Structurals	16.1	14.6	14.5	14.2	15.1	16.2	17.1	16.6
Cold Finished Bars, Tool Steel	3.4	2.2	2.4	2.0	2.0	1.6	1.9	2.1
Seamless Pipe and Welded Pipe	10.4	12.3	11.6	9.9	9.4	8.6	8.3	9.0
Hot Sheet and Strip	13.5	14.0	13.6	13.1	13.4	15.0	17.0	15.7
Cold Rolled Sheet and Strip	8.7	17.3	21.9	23.7	20.9	18.5	20.4	19.6
Galvanized Products	3.0	3.1	3.4	4.7	5.2	5.3	5.9	5.6
Tin and Other Plated Products	5.1	7.5	6.9	8.1	7.4	7.9	6.8	7.1
Plate	12.0	7.9	8.0	8.6	10.5	8.9	8.2	10.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: AISI Annual Statistical Report;
TBS agglomeration into product categories

Exhibit A-15

COMPARATIVE PRODUCTIVITY RATES AMONG MAJOR STEEL PRODUCING NATIONS

1945-1974

(manhours per ton of finished steel)

Year	United States	Japan	West Germany	United Kingdom
1945	14.2	-	-	-
1950	11.9	-	-	-
1955	14.1	62.8	33.6	32.7
1960	15.0	44.2	24.3	29.0
1965	12.2	28.5	21.5	25.0
1970	12.3	12.7	15.6	22.2
1973	10.0	8.5	12.8	21.4
1974	10.0	n.a.	n.a.	n.a.

n.a. = not available

Source: AISI, Steel Industry Economics; and Federal Income Tax Policy, June 1975

Exhibit A-16

CHRONOLOGY OF COLLECTIVE BARGAINING AGREEMENTS WITH UNITED STEELWORKERS UNION

1946-1971

Year	Effective Date of New Agreement[1]	Periods of General Steel Strikes	Length (Calendar Days)
1946	February 15, 1946	January 21--February 17	28
1947	April 22, 1947	-	-
1948	July 16, 1948	-	-
1949	November 11, 1949	October 1--November 11	42
1950	November 30, 1950	-	-
1952	July 26, 1952	April 20--May 2 June 2--July 26	3 55
1953	June 12, 1953	-	-
1954	July 1, 1954	-	-
1955	June 30, 1955	July 1	A Few Hours
1956	August 3, 1956	July 1--August 3	34
1960	January 4, 1960	July 15--November 7, 1959	116
1962	April 6, 1962	-	-
1963	June 29, 1963	-	-
1965	September 1, 1965	-	-
1968	August 1, 1968	-	-
1971	August 1, 1971	-	-

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[1] Some companies have agreements with starting dates other than those listed.

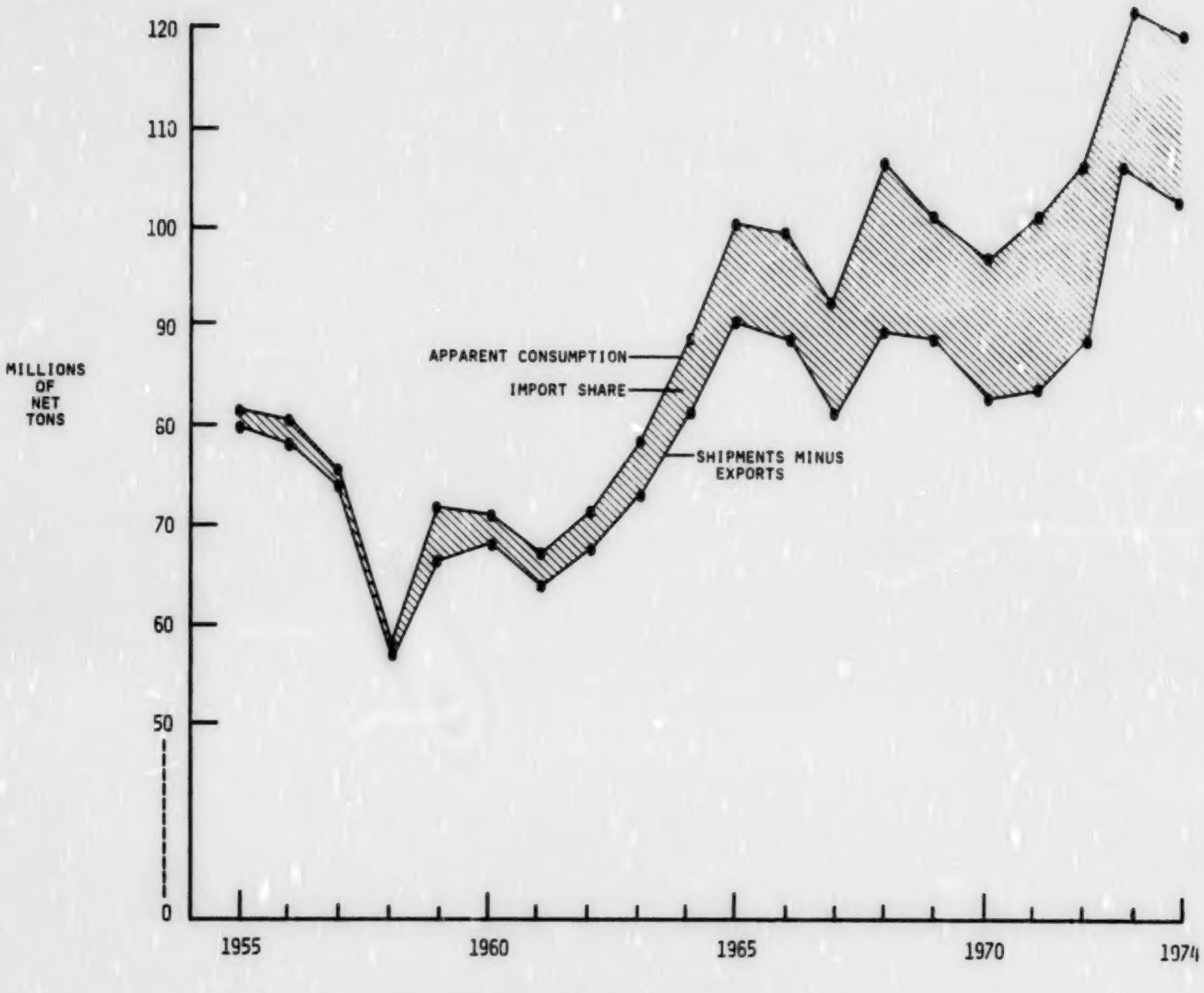
Source: AISI, Annual Statistical Report

EXHIBIT A-17

IMPORT SHARE OF APPARENT U.S. CONSUMPTION OF STEEL

1955 - 1974

(MILLIONS OF NET TONS)



SOURCE: AISI, ANNUAL STATISTICAL REPORT

APPENDIX B

INDUSTRY BASELINE CONDITIONS

APPENDIX B

LIST OF EXHIBITS

Exhibit

B-1 Projections of Steel Shipments by Product, 1975-1983

B-2 Steel Shipments by Product Category, 1972-1983

B-3 Production Requirements by Process, 1972-1983

B-4 Scrap Sources and Uses, 1972-1983

B-5 Capacity Requirements by Process, 1972-1983

B-6 Capacity Additions, 1975-1983

B-7 Actual Utilization by Process, 1972-1983

B-8 Capital Expenditures for Capacity Expansion and Modernization, 1975-1983

B-9 Operations and Maintenance Expenses for Iron and Steel Production by Time Period, 1975-1983

INDUSTRY BASELINE CONDITIONS

Section 2 of the report provides summary findings regarding industry baseline conditions. This section supplements those findings by presenting the findings of the study regarding production activities only. Findings related to pollution control equipment including equipment in place in 1974 and contained in Appendices C and D.

STEEL SHIPMENTS

Shipments for the baseline case continue the trend from 1960-1974 of 2.53 million additional tons per year except for the recent downturn. Steel shipments in 1975, estimated at about 83 million tons, will be used rather than the trend value of 107.9 million tons. Domestic shipments are assumed to return to the trend by 1977, since the 1975 downturn in shipments is more a result of inventory reduction by steel users than of a drop in consumption.

STEEL CONSUMPTION
(millions of tons)

	1972	1973	1974	1975	1976
Consumption	106.8	117.5	114.3	103.9	110.5
Inventory increase	.1	5.2	5.5	-11.0	0
Total Shipments	91.8	111.4	109.5	82.9	98.0
Imports	15.1	11.3	10.3	10.0	12.5
Cumulative inventory increase	.1	5.3	10.8	-.2	-.2

Source: AISI Advisory Committee, December 2, 1975

From the table above, it can be seen that while domestic shipments decreased 24.3 percent, from 109.5 to 83 million tons, between 1974 and 1975, consumption decreased only 9.1 percent. The difference is a reduction in steel user inventory of 11 million tons. If consumption returns to the level of 110 million tons, which is about the average of 1972-1975, and no further inventory reduction occurs, steel shipments should rebound to 98.0 million tons in 1976. Since consumption has not varied as much as shipments during the last four years, this forecast is used.

Steel shipments forecast used in this analysis are shown in the table below for selected years.[1]

STEEL SHIPMENTS
(millions of tons)

	1975	1977	1980	1983
Baseline Case	82.9	113.0	120.6	128.2

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[1] *The analysis reported herein is limited to steelmaking and finishing facilities which represent 93 percent of domestic shipments. Thus the corresponding baseline forecast of shipments would be 105.1 million tons in 1977, 112.2 million tons in 1980, and 119.2 million tons in 1983.*

PRODUCT SHIPMENTS

The trends in product mix change from 1960 to 1974 are expected to continue during the period of this analysis. Exhibit B-1 contains projections of the percentage of total shipments for each of the twelve product categories used in this analysis. Actual product mix was used for 1972 through 1974.

Projected shipments of each product category are contained in Exhibit B-2. Shipments of each product increase in each year from 1975 through 1983. Comparison with Exhibit B-1 shows that some products increase more than others. For example, bars and light structurals increase from 11.7 to 19.8 million tons and from 15.2 percent to 16.6 percent of total shipments. However, welded pipe decreases from 6.0 to 5.4 percent of shipments while increasing from 4.7 to 6.4 million tons.

PRODUCTION REQUIREMENTS

Production requirements for all processes except open hearth increase from 1975 to 1983. Exhibit B-3 is a tabulation of production by process for selected years. Open hearth production decreases due to the shift to basic oxygen and electric furnaces. By 1983, open hearth production will only be 55 percent of its peak in 1974. The conventional forming processes reach a peak in 1977 and then begin to decline as continuous casting increases almost 300 percent from 1975 to 1983.

The effects on production requirements which result from shifts observed in product shipments are much smaller than those which result from changes in technology. For example, bars and light structurals have only a 1.4 percent increase in shipments and a corresponding increase in production requirement by 1983, compared to a 300 percent increase in continuous casting.

The effects of technology shifts on indirectly affected processes are also significant. While total shipments increase 54.6 percent from 1975 to 1983, production of molten steel increases only 50.6 percent. This occurs because the shift from conventional casting and breaking to continuous casting has a significant impact on the yield from furnace output to billets, blooms, and slabs. Higher yields for continuous casting mean that less molten steel will be required for each ton of product shipped. The amount of molten steel required per ton of product shipped is reduced from 1.45 in 1972 to 1.44 in 1975 and 1.40 in 1983. In addition to reducing the relative amounts of furnace production required, requirements for all processes which feed the steelmaking furnaces are reduced by this improvement.

This reduction in molten steel per ton of product will not necessarily reduce the amount of scrap purchased. Primary breaking is a major source of internally generated scrap as seen from Exhibit B-4. Substitution of continuous casting for primary breaking will reduce the scrap generated in steel forming from .21 tons scrap per ton of production in 1975 to .18 tons scrap per ton of production in 1983. This loss of internally generated scrap will result in a need to purchase greater amounts of scrap to maintain the same furnace feed. In 1975 purchased scrap is 48 percent of the total. By 1983, this will increase to 51 percent. This increased requirement for scrap is not expected to inhibit the shift to continuous casting. The growth in scrap purchased is only 6.1 percent per year. In addition, the charge of scrap into the steel furnaces can be decreased by increasing the charge of molten iron or by utilizing a greater proportion of basic oxygen furnaces than forecast.

CAPACITY REQUIREMENTS

Capacity must increase significantly by 1983. Production to meet total shipments in 1983 will be 14 percent greater than the peak of 1973 when facilities operated at 100 percent utilization for a short period. Except for the 5 processes being replaced by competing technologies, 16 of the remaining 23 processes require additional capacity by 1983. Exhibit B-5 lists the capacity requirements by process for selected years. Actual capacity for 1972 is included. Capacity additions are the difference between requirements and existing capacity and are summarized in Exhibit B-6.

The greatest amount of additions occur in processes which precede casting and forming. Increases are required for seven of the nine processes not affected by technology shifts. Two processes affected by technology change, basic oxygen furnace and electric furnaces, require additions of 42 and 70 percent respectively. These dramatic increases are caused both by the shift away from open hearth furnaces and the requirement to provide more steelmaking to meet shipment needs. With the exception of the requirements for continuous casting, the capacity additions required for steel forming and finishing processes are much smaller than those required for steelmaking.

Five of the fourteen processes not involved in changing technology require no additions. The largest additions among the forming and finishing processes are for processes with small capacities. For example, welded pipe increases 85 percent, from only 4.7 to 8.7 million tons, and cold coatings increase 51 percent, from 6.8 to 10.3 million tons. Major processes, such as hot strip and sheet with 85.7 million tons and cold strip and sheet with 63 million tons, have no capacity increases.

Comparison of the capacity requirements listed in Exhibit B-5 to the production requirements in Exhibit B-3 determine the realized utilizations for each process. These utilizations are set out in Exhibit B-7. By 1983, twelve processes will be operating below their planning utilizations. However, five of these are being phased out in favor of more modern technologies. The remaining seven processes are:

- Ore yards
- Sinter strand
- Heavy structurals
- Hot bar
- Cold bars
- Pickling and oiling
- Cold rolled strip

CAPACITY MODERNIZATION

The expenditures required to maintain the production capacity and to update the technology of existing units are referred to as capacity modernization. Expenditures for modernization do not normally increase capacity--in effect, they forestall possible decreases in capacity due to old and unreliable or obsolete equipment. Thus, there is no observable quantitative measure of the need for such expenditures. The amount required is based upon historic trends which indicate a consistent annual expenditure related to the value of the process is expended for capacity modernization.

CAPITAL EXPENDITURES FOR EXPANSION AND MODERNIZATION

The capital expenditures implied by the above-mentioned schedule of capacity additions are as follows:

CAPITAL EXPENDITURES FOR
EXPANSION AND MODERNIZATION
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capacity Expansion		
Placed Into Service	$3.33	$ 9.61
Changes in Construction Work in Progress	0.40	2.01
TOTAL	$3.73	$11.62
Capacity Modernization	4.99	15.89
GRAND TOTAL	$8.72	$27.50

These capital expenditures for capacity expansion and modernization are detailed by production process in Exhibit B-8.

CAPACITY EXPANSION

Sixty percent of the capital expenditures for capacity additions will occur in steel forming and finishing processes. The previous section pointed out that the greatest addition of capacity would occur in the processes which precede forming and finishing. However, capital expenditures are higher in the latter processes largely due to the higher cost per unit of capacity additions.

Additional continuous casting capacity accounts for 20.7 percent of all capital expenditures for capacity expansion. Since expansion of traditional breaking mills would be required without this change, a large portion of these expenditures would be required whether a shift to continuous casting occurred or not.

Of the steel finishing processes, the largest use of funds is for welded pipe mills which represent over 10 percent of the total. This reflects both the increased need for capacity in this process and its very high cost per unit of additional capacity. At $422.00 per ton, welded pipe capacity is the most capital intensive process on a per-ton basis.

The pattern of projected capital expenditures in steelmaking clearly reflects projected changes in technology, as well as increased capacity requirements. Basic oxygen and electric furnaces account for 16 percent of total capital expenditures.

Of the remaining raw material, iron-making and steel-making processes, coke ovens require the next largest share of total capital expenditures. From 1975-1983, coke ovens will require 14 percent of all capital expenditures for capacity expansion. The other processes in this group account for only 10 percent of the total expenditures. This need for additional coke oven capacity reflects the current full utilization of these units. This utilization in turn probably reflects an industry reluctance in the recent past to add coke oven capacity in the face of considerable uncertainty regarding the effect of environmental, and occupational safety and health act standards on the existing coke oven process. Although a new process called "form coke" has been developed that may meet environmental and OSHA standards, this process is not a panacea because of its high energy input and some uncertainties concerning its performance in large-scale blast furnaces. Therefore, presuming no superior technology emerges in the near term, significant additions to conventional coke oven capacity will be required by 1983.

MODERNIZATION

Capital expenditures for modernization are required for every process. As can be seen in Exhibit B-8 there are large differences in amount by process. The highest expenditures for modernization are for cold rolling mills, reflecting the large amount of cold rolling capacity in place and a relatively high rate of modernization costs per ton of existing capacity.

OPERATING AND MAINTENANCE EXPENSES[2]

Operations and maintenance expenses represent the largest component of annual steel industry costs. These expenditures, which are expected to total $279.9 billion during the period 1975 to 1983, are dominated by basic raw material costs and labor-related charges. The remainder of O&M expenditures are attributable to a variety of elements and miscellaneous maintenance supplies.

PTm(Steel) computes input requirements from the previously cited production requirements for each process. O&M expenses are determined by combining these requirements with prices for each resource employed.

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[2] *Operations and maintenance expenses for iron and steel production as defined herein include direct labor and overhead, raw materials, energy, supplies, and other utilities, but exclude depreciation and other capital charges.*

COST CATEGORIES

O&M expenditures for each major resource factor are listed in the table below:

OPERATING AND MAINTENANCE EXPENSES FOR
IRON AND STEEL PRODUCTION
1975-1983

(billions of 1975 dollars)

Raw Materials		
Ore	$41.28	
Coal	32.93	
Scrap	66.44	$140.65
Labor		45.37
Overhead		54.56
Electric Power		9.90
Fuel		.08
Other		29.35
TOTAL		$279.91

Fuel is perhaps surprisingly small due to the large energy credits available from coke ovens and blast furnaces. It is assumed that energy from these processes will be used directly by other processes or consumed in generating electric power.

COSTS BY PROCESS

O&M costs for each process are shown in Exhibit B-9. Raw materials preparation clearly contributes the greatest amount of any category to O&M. However, the cost of raw material inputs, $140.6 billion, dominates this category. O&M for Raw Materials Preparation, exclusive of raw material costs, is $9.6 billion.

The category which contributes the greatest portion of O&M, exclusive of raw materials cost, is finishing. This occurs since some finishing mills are costly to operate and also because after being formed, some products must be processed through several finishing mills before shipment.

Throughout the period from 1975 to 1983, annual O&M costs increase as shipment and production volumes increase. However, the O&M cost per ton rises only about 1.1 percent per year from $260.01 in 1977 to $284.17 in 1983.

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Exhibit B-1

PROJECTIONS OF STEEL SHIPMENTS BY PRODUCT

1975-1983

(percentage of total shipments)

Product Category	Actual		Projections			
	1972	1974	1975	1977	1980	1983
Direct Shipments of Ingots, Blooms, Billets, and Slabs	3.3	3.3	5.3	4.2	4.4	4.5
Heavy Structurals	7.9	8.2	8.3	8.1	8.1	8.0
Bars and Rods	17.1	16.6	15.2	16.4	16.5	16.6
Nails and Wire Products	3.2	2.9	3.7	2.9	2.7	2.6
Cold Finished Bars	1.9	2.1	1.8	2.0	2.0	2.0
Seamless Pipe	2.9	2.4	3.4	3.0	3.0	2.9
Welded Pipe	5.4	6.6	6.0	5.6	5.5	5.4
Hot Rolled Sheet and Strip	17.0	15.7	13.8	16.1	16.5	16.8
Cold Rolled Sheet and Strip	20.4	19.6	20.9	19.8	19.5	19.3
Galvanized Products	5.9	5.6	5.2	5.9	6.0	6.0
Tin and Other Plated Products	6.8	7.1	7.4	6.7	6.6	6.4
Plates	8.2	10.0	9.0	9.3	9.3	9.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: AISI Annual Statistical Report and PTm(Steel) projections

Exhibit B-2

STEEL SHIPMENTS BY PRODUCT CATEGORY*
1972-1983
(millions of tons)

Product Category	1972	1974	1975	1977	1980	1983
Direct Shipments of Ingots, Billets, Blooms	2.9	3.3	4.1	4.3	4.8	5.4
Heavy Structurals and Rails	6.8	8.4	6.4	8.6	9.1	9.6
Nails and Wire Products	2.7	3.0	2.9	3.1	3.1	3.1
Bars and Light Structurals	14.6	16.9	11.7	17.2	18.5	19.8
Cold Finished Bars	1.6	2.1	1.4	2.1	2.2	2.4
Seamless Pipe	2.5	2.4	2.6	3.2	3.3	3.4
Welded Pipe	4.7	6.7	4.7	5.9	6.1	6.4
Hot Rolled Sheet and Strip	14.5	16.0	10.6	16.9	18.5	20.1
Cold Rolled Sheet and Strip	17.4	19.9	16.1	20.8	21.9	23.1
Galvanized Products	5.0	5.7	4.0	6.2	6.7	7.2
Tin and Other Plated Products	5.8	7.3	5.7	7.1	7.4	7.6
Plate	7.0	10.2	7.0	9.8	10.4	11.2
Total	85.5	101.9	77.2	105.2	112.0	119.3

**93 percent of the industry*

Source: PTm(Steel)

Exhibit B-3

PRODUCTION REQUIREMENTS BY PROCESS
1972-1983

(millions of tons)

Process	1972	1974	1975	1977	1980	1983
Raw Materials Preparation						
Ore Yard	127.4	150.4	113.5	153.7	162.4	170.9
Coal Yard	65.7	77.6	58.6	79.3	83.8	88.2
Scrap Yard	63.5	76.0	57.7	78.0	82.6	86.6
Sinter Strand	28.2	33.3	25.1	34.0	36.0	37.9
Coke Ovens	46.0	54.3	40.9	55.4	58.6	61.7
Ironmaking						
Blast Furnace	80.6	95.2	71.8	97.3	102.8	108.2
Steelmaking						
Open Hearth Furnace	32.4	36.7	25.8	30.1	24.7	20.1
Basic Oxygen Furnace	69.2	82.8	63.9	90.2	100.7	110.4
Electric Furnace	22.0	27.3	21.5	30.3	33.9	37.0
Vacuum Degassing	31.6	38.9	29.8	42.0	47.0	51.4
Casting and Forming						
Continuous Casting						
Billets and Blooms	3.3	4.5	4.2	7.3	10.4	15.5
Slabs	4.8	9.5	5.7	10.7	16.2	23.0
Conventional Casting						
Ingot Casting	112.8	129.4	98.7	128.9	128.6	124.3
Breaking--Blooms	21.6	25.8	19.8	25.0	24.5	22.4
Breaking--Billets	21.9	26.0	20.0	26.1	26.4	25.5
Breaking--Slabs	63.9	72.1	54.5	72.1	72.0	70.8
Finishing Mills						
Heavy Structural	6.7	8.4	6.4	8.5	9.1	9.6
Hot Rolled Bar and Rod	19.1	22.1	16.1	22.4	23.9	25.5
Wire Product	2.7	3.0	2.8	3.0	3.1	3.1
Cold Finished Bar	1.6	2.1	1.4	2.1	2.2	2.4
Seamless Pipe and Tube	1.4	2.4	2.6	3.2	3.3	3.5
Hot Rolled Strip	56.4	64.7	48.0	66.1	70.4	74.7
Pickling and Oiling	45.2	52.3	39.5	53.1	56.3	59.5
Welded Pipe and Tube	5.7	6.7	4.6	5.9	6.2	6.5
Cold Rolled Strip	28.8	33.4	26.2	34.5	36.5	38.5
Hot Coating--Galvanizing and Terne	5.1	5.7	4.0	6.2	6.7	7.2
Cold Coating--Tin and Chrome	5.8	7.3	5.7	7.1	7.4	7.7
Plate	7.0	10.2	6.9	9.8	10.4	11.1

Source: PTm(Steel)

Exhibit B-4

SCRAP SOURCES AND USES
1972-1983
(thousands of tons)

	1972	1975	1977	1980	1983
Tons Consumed					
Scrap Yard	1,270	1,154	1,561	1,651	1,733
Open Hearth Furnace	16,832	13,409	15,652	12,838	10,452
Basic Oxygen Furnace	22,140	20,451	28,848	32,212	35,322
Electric Furnace	23,245	22,674	31,975	35,860	39,127
Tons Generated Internally					
Blast Furnace	806	718	973	1,028	1,082
Ingot Casting	2,256	1,975	2,578	2,571	2,487
Billets and Blooms	98	125	219	313	466
Slabs	192	229	429	649	919
Breaking--Blooms	2,377	2,179	2,752	2,694	2,462
Breaking--Billets	2,845	2,594	3,393	3,433	3,317
Breaking--Slabs	12,145	10,347	13,689	13,689	13,450
Heavy Structural	1,349	1,285	1,709	1,810	1,911
Hot Rolled Bar and Rod	1,719	1,450	2,018	2,155	2,291
Seamless Pipe and Tube	217	421	511	535	559
Hot Rolled Strip	2,254	1,921	2,643	2,815	2,987
Pickling and Oiling	1,809	1,579	2,123	2,252	2,381
Welded Pipe and Tube	572	463	593	621	649
Cold Rolled Strip	3,451	3,143	4,146	4,384	4,622
Hot Coating--Galvanizing and Terne	103	79	123	134	144
Cold Coating--Tin and Chrome	116	115	141	148	154
Plate	1,616	1,594	2,243	2,400	2,556

Source: PTm(Steel)

Exhibit 8-5

CAPACITY REQUIREMENTS BY PROCESS

1972-1983

(millions of tons)

Process	1972	1974	1975	1977	1980	1983
Raw Materials Preparation						
Ore Yard	202.7	202.7	202.7	202.7	202.7	202.7
Coal Yard	85.7	85.7	85.7	88.1	93.1	98.0
Scrap Yard	75.3	75.3	75.3	86.7	91.7	96.3
Sinter Strand	46.9	46.9	46.9	46.9	46.9	46.9
Coke Ovens	59.5	59.5	59.5	61.6	65.1	68.5
Ironmaking						
Blast Furnace	109.5	109.5	109.5	109.5	114.2	120.2
Steelmaking						
Open Hearth Furnace	49.1	49.1	49.1	49.1	49.1	49.1
Basic Oxygen Furnace	86.3	86.3	86.3	100.2	111.8	122.6
Electric Furnace	25.8	25.8	25.8	33.6	37.7	41.1
Vacuum Degassing	39.1	39.1	39.7	56.0	62.6	68.6
Casting and Forming						
Continuous Casting						
Billets and Blooms	5.7	5.7	5.7	8.1	11.6	17.3
Slabs	8.0	8.0	8.0	11.9	18.0	25.5
Conventional Casting						
Ingot Casting	150.6	150.6	150.6	150.6	150.6	150.6
Breaking--Blooms	40.1	40.1	40.1	40.1	40.1	40.1
Breaking--Billets	37.3	37.3	37.3	37.3	37.3	37.3
Breaking--Slabs	84.8	84.8	84.8	84.8	84.8	84.8
Finishing Mills						
Heavy Structural	12.9	12.9	12.9	12.9	12.9	12.9
Hot Rolled Bar and Rod	34.1	34.1	34.1	34.1	34.1	34.1
Wire Product	2.8	2.8	3.8	4.0	4.1	4.1
Cold Finished Bar	3.4	3.4	3.4	3.4	3.4	3.4
Seamless Pipe and Tube	3.7	3.7	3.7	4.3	4.5	4.7
Hot Rolled Strip	85.7	85.7	85.7	85.7	85.7	87.9
Pickling and Oiling	72.6	72.6	72.6	72.6	72.6	72.6
Welded Pipe and Tube	4.7	4.7	6.2	7.9	8.3	8.7
Cold Rolled Strip	63.0	63.0	63.0	63.0	63.0	63.0
Hot Coating--Galvanizing and Terne	7.6	7.6	7.6	8.2	8.9	9.6
Cold Coating--Tin and Chrome	6.8	6.8	7.6	9.4	9.8	10.3
Plate	12.8	12.8	12.8	13.0	13.9	14.8

Source: PIm(Steel)

Exhibit B-6

CAPACITY ADDITIONS
1975-1983
(millions of tons)

Process	1975-1983
Raw Materials Preparation	
Ore Yard	0
Coal Yard	12.3
Scrap Yard	21.0
Sinter Strand	0
Coke Ovens	9.0
Ironmaking	
Blast Furnace	10.7
Steelmaking	
Open Hearth Furnace	0
Basic Oxygen Furnace	36.3
Electric Furnace	15.3
Vacuum Degassing	29.5
Casting and Forming	
Continuous Casting	
Billets and Blooms	11.6
Slabs	17.5
Conventional Casting	
Ingot Casting	0
Breaking--Blooms	0
Breaking--Billets	0
Breaking--Slabs	0
Finishing Mills	
Heavy Structural	0
Hot Rolled Bar and Rod	0
Wire Product	1.3
Cold Finished Bar	0
Seamless Pipe and Tube	1.0
Hot Rolled Strip	1.7
Pickling and Oiling	0
Welded Pipe and Tube	4.0
Cold Rolled Strip	0
Hot Coating--Galvanizing and Terne	2.0
Cold Coating--Tin and Chrome	3.5
Plate	2.0

Source: PTm(Steel)

Exhibit B-7

ACTUAL UTILIZATION BY PROCESS
1972-1983
(percent of total capacity)

Process	1972	1975	1977	1980	1983
Raw Materials Preparation					
Ore Yard	62.8	56.0	75.8	80.1	84.3
Coal Yard	76.7	68.4	90.0	90.0	90.0
Scrap Yard	84.3	76.6	90.0	90.0	90.0
Sinter Strand	60.2	53.7	72.6	76.8	80.8
Coke Ovens	77.2	68.8	90.0	90.0	90.0
Ironmaking					
Blast Furnace	73.6	65.6	88.8	90.0	90.0
Steelmaking					
Open Hearth Furnace	65.9	52.5	61.3	50.3	40.9
Basic Oxygen Furnace	80.2	74.1	90.0	90.0	90.0
Electric Furnace	85.2	83.1	90.0	90.0	90.0
Vacuum Degassing	81.0	75.0	75.0	75.0	75.0
Casting and Forming					
Continuous Casting					
Billets and Blooms	57.0	72.7	90.0	90.0	90.0
Slabs	60.1	71.4	90.0	90.0	90.0
Conventional Casting					
Ingot Casting	74.9	65.6	85.6	85.4	82.6
Breaking--Blooms	53.8	49.4	62.3	61.0	55.8
Breaking--Billets	58.7	53.6	70.0	70.9	68.5
Breaking--Slabs	75.3	64.2	84.9	84.9	83.4
Finishing Mills					
Heavy Structural	52.1	49.6	66.0	69.9	73.8
Hot Rolled Bar and Rod	55.9	47.2	65.7	70.1	74.6
Wire Product	96.8	75.0	75.0	75.0	75.0
Cold Finished Bar	45.6	41.5	60.7	65.4	70.0
Seamless Pipe and Tube	36.8	71.3	75.0	75.0	75.0
Hot Rolled Strip	65.7	56.0	77.1	82.1	85.0
Pickling and Oiling	62.3	54.4	73.2	77.6	82.0
Welded Pipe and Tube	120.7	75.0	75.0	75.0	75.0
Cold Rolled Strip	45.6	41.5	54.8	57.9	61.1
Hot Coating--Galvanizing and Terne	67.9	52.6	75.0	75.0	75.0
Cold Coating--Tin and Chrome	85.1	75.0	75.0	75.0	75.0
Plate	55.0	54.3	75.0	75.0	75.0

Source: PTm(Steel)

Exhibit B-8

CAPITAL EXPENDITURES FOR CAPACITY EXPANSION AND MODERNIZATION 1975-1983

(billions of 1975 dollars)

Process	Capacity Expansion	Modernization
Raw Materials Preparation		
Ore Yard	$ .00	$ .19
Coal Yard	.13	.08
Scrap Yard	.13	.05
Sinter Strand	.00	.10
Coke Ovens	1.37	1.16
Iron Making		
Blast Furnace	.65	1.61
Steelmaking		
Open Hearth Furnace	.00	.15
Basic Oxygen Furnace	1.09	.25
Electric Furnace	.44	.11
Casting and Forming		
Continuous Casting		
Billets and Blooms	.95	.03
Slabs	1.04	.07
Conventional Casting		
Ingot Casting	.00	.08
Breaking--Blooms	.00	.61
Breaking--Billets	.00	1.19
Breaking--Slabs	.00	1.25
Finishing Mills		
Heavy Structural	.00	.29
Hot Rolled Bar and Rod	.00	1.77
Wire Product	.55	.55
Cold Finished Bar	n.a.	n.a.
Seamless Pipe and Tube	.34	.37
Hot Rolled Strip	.17	1.52
Pickling and Oiling	.00	.66
Welded Pipe and Tube	.98	.64
Cold Rolled Strip	.00	2.05
Hot Coating--Galvanized and Terne	.68	.35
Cold Coating--Tin and Chrome	.64	.55
Plate	.45	.19
Subtotal	$9.61	$15.89
Construction Work in Progress	2.01	.00
TOTAL	$11.62	$15.89

n.a. = not available

Source: PTm (Steel)

Exhibit B-9

OPERATIONS AND MAINTENANCE EXPENSES FOR IRON AND STEEL PRODUCTION BY TIME PERIOD
1975-1983

(billions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation				
Ore Yard	$12.19	$15.12	$16.36	$43.68
Coal Yard	8.40	11.68	14.26	34.34
Scrap Yard	18.98	24.17	27.46	70.62
Sinter Strand	.96	1.16	1.22	3.33
Coke Ovens	(.51)	(.57)	(.61)	(1.69)
Ironmaking				
Blast Furnace	.90	1.10	1.14	3.15
Steelmaking				
Open Hearth Furnace	4.04	3.88	3.15	11.07
Basic Oxygen Furnace	5.71	7.25	7.99	20.96
Electric Furnace	4.03	5.06	5.50	14.59
Vacuum Degassing	n/a	n/a	n/a	n/a
Casting and Forming				
Continuous Casting				
Billets and Blooms	.16	.26	.38	.78
Slabs	.95	1.69	2.39	5.03
Conventional Casting				
Ingot Casting	1.42	1.61	1.58	4.61
Breaking--Blooms	.82	.93	.87	2.61
Breaking--Billets	1.17	1.37	1.35	3.89
Breaking--Slabs	.54	.68	.69	1.91
Finishing Mills				
Heavy Structural	.25	.31	.33	.89
Hot Rolled Bar and Rod	1.95	2.43	2.59	6.96
Wire Product	.78	.83	.84	2.46
Cold Finished Bar	n/a	n/a	n/a	n/a
Seamless Pipe and Tube	.50	.57	.59	1.66
Hot Rolled Strip	4.81	5.89	6.25	16.95
Pickling and Oiling	.96	1.18	1.25	3.40
Welded Pipe and Tube	.87	1.01	1.06	2.94
Cold Rolled Strip	3.51	4.25	4.49	12.26
Hot Coating--Galvanizing and Terne	.76	.99	1.07	2.81
Cold Coating--Tin and Chrome	1.46	1.65	1.71	4.81
Plate	1.64	2.05	2.19	5.88
TOTAL	$77.27	$96.56	$106.07	$279.91

Source: PTm(Steel)

APPENDIX C

COST IMPACT OF FEDERAL WATER POLLUTION CONTROL ACT AND OTHER WATER POLLUTION REGULATIONS

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APPENDIX C

LIST OF EXHIBITS

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COST IMPACT OF FEDERAL WATER POLLUTION CONTROL ACT AND OTHER WATER POLLUTION REGULATIONS

COSTING METHODOLOGY

The twenty-eight production processes utilized throughout this analysis are based upon the unit operations which constitute the steel industry. Each process produces only one output. Each product follows a unique path from process to process transforming raw materials to finished products. Thus changes in production requirements for any product can be translated into changed production requirements for each process. Because of this relationship, these production processes can accurately reflect the production requirements and costs of the steel industry.

The thirty-one water pollution control subcategories specified in the effluent limitation guidelines are based upon wastewater streams which contain similar mixes of pollutants. These subcategories are useful for consideration of treatment alternatives and attendant costs. However, these subcategories do not always correspond to the actual production processes. In some cases, a production process may generate more than one waste stream with different pollutants treated under different effluent limitation subcategories. In other cases, an effluent limitation subcategory may include similar waste streams from several production processes. Finally, a waste stream from a single production process may permit treatment alternatives so different that separate subcategories are specified. Corresponding production processes and effluent limitation subcategories are matched in Exhibit C-1.

In cases such as the basic oxygen furnace, where alternate effluent limitation subcategories are possible, production and productive capacity are assigned on a pro rata basis to each.[1] The specific allocations used in this study are enumerated in Volume II of this report.

Compliance with each standard occurs over time. In fact, many units already have pollution control equipment installed to meet one or more standards. The percent of productive capacity which has such equipment installed in 1974 is specified in Exhibit C-2. The proportion of facilities with equipment to meet BPCTCA guidelines varies from 2 to 100 percent. Similarly, the proportion for BATEA varies from 0 to 100 percent. From the ratios in Exhibit C-2 the amount of capital expenditures already incurred can be determined. These expenditures are only for equipment specified in the effluent limitations guidelines and at the cost to install in 1975. Thus this computation may vary significantly from accrued accounting data. Also, the amount of equipment which must be installed between 1974 and the compliance date is determined from these ratios. The amount installed annually in each subcategory is a proportion of the amount remaining in 1974. The proportions of the untreated capacity brought into compliance in each year in order to achieve 100% compliance in 1979 are shown in the table below.

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[1] *Data to assign pro rata shares were obtained from NUS/Cyrus Rice.*

PROPORTION OF 1975 UNTREATED CAPACITY
TREATED IN EACH YEAR
FOR BPCTCA COMPLIANCE IN 1979

Year	Percentage Brought into Compliance
1975	10%
1976	20%
1977	20%
1978	30%
1979	20%

The basic oxygen furnace is presented as an example of the computation described above. Of basic oxygen furnaces with wet air treatment 76 percent already have water pollution control equipment installed to meet BPCTCA guidelines. Therefore, 24 percent of existing facilities must have equipment installed between 1975 and 1979 to meet BPCTCA limitations. Thus, the amount of capacity fitted with pollution control equipment in 1977 is 4.8 percent of 1974 capacity (i.e., 20% of the 24% of untreated capacity would be brought into compliance).

New facilities meet the applicable guidelines required according to the date they are constructed.

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT

Capital expenditures for water pollution control equipment expected to be placed into service during the 1975-1983 period are detailed by production process in Exhibit C-3. This exhibit also includes the value of facilities already installed by 1974. Coke ovens, blast furnaces, hot rolled strip, and pickling and oiling account for nearly two-thirds of the $1.5 billion value of pollution control equipment in-place. These same procedures also account for nearly one-half of capital expenditures expected during the 1975-1983 period. Capital expenditures for vacuum degassing, slab breaking, hot rolled bars, and plate account for another 20 percent of capital expenditures for process units.

The capital expenditures described above are presented by guideline level in Exhibit C-4 for the 1975-1983 period. The eight processes listed above which account for nearly 80 percent of capital expenditures for production processes represent 81 percent of capital expenditures for BPCTCA, 85 percent of BATEA expenditures, and 38 percent of capital expenditures for NSPS. Viewed in another way, of the $1.9 billion required to be spent for these eight processes, only $.1 billion is for New Source Performance Standards. Thus $1.8 billion is to treat wastes from production facilities which already are in service or are under construction.

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

Projected operations and maintenance expenses associated with equipment placed into service during the 1975-1983 period are detailed by production process in Exhibit C-5. O&M expenses for equipment in service in 1974 are detailed in Exhibit C-6. The total O&M for all equipment to achieve full compliance with the effluent limitations guidelines is contained in Exhibit C-7.

Exhibit C-7 illustrates that the same eight processes which dominate capital expenditures for pollution control equipment also dominate the O&M expenses. The eight processes account for 81 percent of O&M for specific production processes.

O&M expenses separated by the effluent limitations guideline levels are shown in Exhibit C-8 for pollution control equipment placed into service by 1974. O&M expenses for equipment already in service in 1974 are contained in Exhibit C-9, and the total is presented in Exhibit C-10.

COMPARISON OF ALTERNATIVE ENGINEERING COST ESTIMATES FOR WATER POLLUTION CONTROL EQUIPMENT

Comparison of alternative engineering cost estimates with the baseline described above must consider differences in assumptions. Thus while PTm(Steel) is designed to accept alternative engineering cost estimates, correct comparisons are possible only when variations due to extraneous factors are eliminated.

ARTHUR D. LITTLE ENGINEERING COST ESTIMATES

Comparisons of capital expenditures and O&M expenses using NUS/Cyrus Rice and Arthur D. Little (ADL) engineering cost estimates are presented in Exhibits C-11 and C-12, respectively. In order to make appropriate comparisons, the results based upon ADL engineering cost estimates use the baseline shipment forecast and do not include savings from commingling waste streams.

In comparison with the projections based on the NUS/Cyrus Rice estimates, both capital expenditures and O&M expenses based on the ADL estimates are significantly higher for coke ovens and blast furnaces and lower for hot rolled bar mills and vacuum degassing. In addition, the ADL estimates lead to significantly lower projections of O&M expenses for pickling and oiling, welded pipe and tube, and plate mills.

Capital expenditures computed by PTm(Steel) using ADL engineering cost estimates are compared to figures from pages I-7 and VI-59 of their report in the table below:

COMPARISON OF CAPITAL EXPENDITURES
ARTHUR D. LITTLE REPORT VS. PTm(STEEL) USING
ARTHUR D. LITTLE ENGINEERING COST ESTIMATES
(billions of 1975 dollars)

	ADL Report	PTm(Steel) ADL Engineering Cost Estimates
BPCTCA (water 1977)	$2.94	$3.46
BATEA (water 1983)	.56	.96
	$3.50	$4.42
New Facilities		
- Additional Capacity	.91	*
	$4.41	$4.42
- Reworked Facilities	.91	0
TOTAL	$5.32	$4.42

**Included above*

In this comparison, PTm(Steel) results based upon ADL estimates include the benefits from commingling waste streams, as does the report by ADL.[2] Since PTm(Steel) does not

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[2] *This table does not compare with Exhibit C-11 since Exhibit C-11 excludes the benefits from commingling waste streams.*

add pollution control equipment to reworked facilities, the correct comparison between the ADL report and PTm(Steel) is BPCTCA and BATEA plus equipment for additional capacity. PTm (Steel) results are within $10 million, or 2 percent, of the comparable figure from the ADL report.

COMMINGLING OF WASTEWATER STREAMS

As discussed above, the baseline case assumes no commingling of wastewater streams. All NUS/Cyrus Rice engineering cost estimates are derived using this assumption. In contrast, ADL engineering cost estimates reflect the benefits of commingling.

Using the ADL factors for potential cost reductions from commingling with the NUS/Cyrus Rice engineering cost estimates, PTm(Steel) produces the comparison below:

EFFECT OF COMMINGLING WASTE STREAMS
ON CAPITAL EXPENDITURES AND OPERATIONS
AND MAINTENANCE EXPENSES
1975-1983

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

(billions of 1975 dollars)

	No Commingling (baseline case)	With Commingling (ADL factors)
Capital Expenditures	$2.49	$2.17
Operations and Maintenance	$3.88	$3.68

If NUS/Cyrus Rice costs are placed on the same basis as ADL with respect to commingling, capital expenditures would be $.3 billion less and O&M $.2 billion less. The opportunities for commingling occur entirely in those processes covered by the Phase II effluent limitations guidelines.

Exhibit C-1

ASSOCIATION OF EFFLUENT LIMITATION SUBCATEGORIES WITH PRODUCTION PROCESSES

EFFLUENT LIMITATION SUBCATEGORIES	PRODUCTION PROCESSES
By-Product Coking--Alternate I By-Product Coking--Alternate II	Coke Ovens
Sintering	Sinter Strand
Blast Furnace	Blast Furnace
Open Hearth Furnace	Open Hearth Furnace
Basic Oxygen Furnace--wet Basic Oxygen Furnace--Semi-wet	Basic Oxygen Furnace
Electric Furnace--Wet Electric Furnace--Semi-Wet	Electric Furnace
Vacuum Degassing	Vacuum Degassing
Continuous Casting	Continuous Casting--Billets and Blooms Continuous Casting--Slabs
- - - - - - - - - -	Conventional Casting--Billets, Blooms, and Slabs
Hot Forming--Primary	Primary Breaking--Blooms Primary Breaking--Slabs
Hot Forming--Section	Primary Breaking--Billets Heavy Structural Hot Rolled Bar and Rod Wire Product
Hot Forming--Hot Strip and Sheet	Hot Rolled Strip
Hot Forming--Plate	Plate
Pipe and Tube--Integrated, Seamless, and Other	Seamless Pipe and Tube
Pipe and Tube--Integrated, Welded	Welded Pipe
Pipe and Tube--Isolated, Seamless, or Welded	Seamless Pipe Welded Pipe
Pickling--H_2SO_4 Batch Concentrates and Rinses	Hot Rolled Bar and Rod Wire Production Cold Finished Bar Pipe and Tube--Seamless
Pickling--H_2SO_4 Continuous Concentrates and Rinses, Neutralization Pickling--H_2SO_4 Continuous Concentrates and Rinses, Acid Recovery	Hot Rolled Strip
Pickling--HCL Continuous Concentrates and Rinses, Neutralization (Alternate I) Pickling--HCL Continuous Concentrates and Rinses, Acid Recovery (Alternate II)	Hot Rolled Strip
Cold Rolling--Recirculation Cold Rolling--Direct Application Cold Rolling--Combination	Cold Reduction and Finishing
Hot Coating--Galvanizing Hot Coating--Terne	Hot Coating--Galvanizing Hot Coating--Terne
Cold Coating--Tin Cold Coating--Chrome	Cold Coating--Tin and Other Plated Products

Exhibit C-2

WATER POLLUTION TREATMENT FACILITIES IN PLACE

1974

(percent of steel industry productive capacity)

	Percent of Capacity With Facilities Installed To Comply With	
Effluent Limitation Subcategories	BPCTCA	BATEA
By-Product Coking--Alternate I	59.0	6.3
By-Product Coking--Alternate II	26.7	1.3
Sintering	60.0	10.0
Blast Furnace	50.0	10.0
Open Hearth Furnace	70.0	0
Basic Oxygen Furnace--Wet	76.0	8.0
Basic Oxygen Furnace--Semi-Wet	80.0	80.0
Electric Furnace--Wet	78.0	12.0
Electric Furnace--Semi-Wet	100.0	100.0
Vacuum Degassing	96.0	18.0
Continuous Casting	100.0	73.0
Hot Forming--Primary	18.0	4.0
Hot Forming--Section	20.0	1.0
Hot Forming--Hot Strip and Sheet	24.0	4.0
Hot Forming--Plate	8.0	8.0
Pipe and Tube--Integrated, Seamless, and Other	16.0	2.0
Pipe and Tube--Integrated, Welded	12.0	5.0
Pipe and Tube--Isolated, Seamless, and Other	20.0	8.0
Pipe and Tube--Isolated, Welded	20.0	8.0
Pickling--H_2SO_4 Batch Concentrates and Rinses	8.0	8.0
Pickling--H_2SO_4 Continuous Concentrates and Rinses, Neutralization	40.0	12.0
Pickling--H_2SO_4 Continuous Concentrates and Rinses, Acid Recovery	2.0	2.0
Pickling--HCL Continuous Concentrates and Rinses, Neutralization (Alternate I)	47.0	12.0
Pickling--HCL Continuous Concentrates and Rinses, Acid Recovery (Alternate II)	8.0	0
Cold Rolling--Recirculation	88.0	88.0
Cold Rolling--Direct Application	70.0	70.0
Cold Rolling--Combination	40.0	40.0
Hot Coating--Galvanizing	48.0	8.0
Hot Coating--Terne	20.0	0
Cold Coating--Tin	35.0	15.0
Cold Coating--Chrome	30.0	0

Source: NUS/Rice engineering data.

Exhibit C-3

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

In-Place 1974 and Additions 1975-1983

(millions of 1975 dollars)

Process	In-Place 1974	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation					
Ore Yard	$ 0	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0	0
Scrap Yard	0	0	0	0	0
Sinter Strand	6	1	1	2	3
Coke Oven	489	10	26	56	93
Ironmaking					
Blast Furnace	283	39	55	39	134
Steelmaking					
Open Hearth Furnace	13	2	2	2	6
Basic Oxygen Furnace	53	6	7	10	22
Electric Furnace	12	3	2	4	10
Vacuum Degassing	91	51	25	40	116
Casting and Forming					
Continuous Casting					
Billets and Blooms	41	16	23	39	77
Slabs	37	17	26	33	76
Conventional Casting					
Ingot Casting	0	0	0	0	0
Breaking--Blooms	17	23	26	10	58
Breaking--Billets	9	12	17	21	50
Breaking--Slabs	31	41	47	18	106
Finishing Mills					
Heavy Structural	10	12	19	24	56
Hot Rolled Bar and Rod	67	100	142	153	396
Wire Product	2	12	7	0*	18
Cold Finished Bar	3	11	12	0	23
Seamless Pipe and Tube	7	13	12	7	32
Hot Rolled Strip	117	151	211	236	597
Pickling and Oiling	97	173	178	11	361
Welded Pipe and Tube	8	30	14	3	47
Cold Rolled Strip	74	15	15	0	30
Hot Coating--Galvanizing and Terne	12	10	11	7	28
Cold Coating--Tin and Chrome	7	15	9	6	29
Plate	15	52	58	7	117
Subtotal	$1,500	$ 814	$ 943	$729	$2,486
Changes in Construction Work in Progress	0	768	(144)	(285)	339
TOTAL	$1,500	$1,582	$ 799	$444	$2,825
Storm Runoff	0	17	83	46	146
Other Water	0	159	290	151	600
GRAND TOTAL	$1,500	$1,758	$1,172	$641	$3,571

*Less than .5 million

Source: PTm (Steel) projections

Exhibit C-4

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY EFFLUENT GUIDELINE

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

Additions 1975-1983

(millions of 1975 dollars)

Process	BPCTCA	BATEA	NSPS	TOTAL
Raw Materials Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	1	2	0	3
Coke Oven	11	69	12	93
Ironmaking				
Blast Furnace	77	39	17	134
Steelmaking				
Open Hearth Furnace	0	6	0	6
Basic Oxygen Furnace	4	9	10	22
Electric Furnace	2	4	4	10
Vacuum Degassing	22	42	51	116
Casting and Forming				
Continuous Casting				
Billets and Blooms	3	1	74	77
Slabs	3	1	72	76
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	45	13	0	58
Breaking--Billets	22	28	0	50
Breaking--Slabs	82	24	0	106
Finishing Mills				
Heavy Structural	24	32	0	56
Hot Rolled Bar and Rod	192	204	0	396
Wire Product	18	0	0**	18
Cold Finished Bar	23	0	0	23
Seamless Pipe and Tube	21	9	3	32
Hot Rolled Strip	288	295	14	597
Pickling and Oiling	347	14	0	361
Welded Pipe and Tube	40	3	4	47
Cold Rolled Strip	30	0	0	30
Hot Coating--Galvanizing and Terne	17	6	6	29
Cold Coating--Tin and Chrome	18	8	3	29
Plate	103	0	14	117
Subtotal	$1,392	$ 812	$ 283	$2,486
Changes in Construction Work In Progress	151	63	125	339
TOTAL	$1,543	$ 875	$ 408	$2,825
Storm Runoff	0	0	0	146
Other Water	0	0	0	600
GRAND TOTAL	$1,543	$ 875	$ 408	$3,571

*Includes changes in construction work in progress
**Less than .5 million

Source: PTm (Steel) projections

Exhibit C-5

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT INSTALLED 1975-1983 BY TIME PERIOD

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Material Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	**	**	1	1
Coke Oven	8	43	108	158
Ironmaking				
Blast Furnace	5	28	82	117
Steelmaking				
Open Hearth Furnace	**	**	**	1
Basic Oxygen Furnace	2	7	11	20
Electric Furnace	*	1	2	4
Vacuum Degassing	12	33	57	101
Casting and Forming				
Continuous Casting				
Billets and Blooms	1	7	14	22
Slabs	2	9	17	28
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	3	9	11	23
Breaking--Billets	1	6	10	18
Breaking--Slabs	7	25	32	65
Finishing Mills				
Heavy Structural	1	6	12	19
Hot Rolled Bar and Rod	15	60	97	173
Wire Product	8	13	14	35
Cold Finished Bar	2	6	7	16
Seamless Pipe and Tube	4	12	15	31
Hot Rolled Strip	26	103	165	295
Pickling and Oiling	28	100	118	246
Welded Pipe and Tube	15	26	29	70
Cold Rolled Strip	4	12	14	30
Hot Coating--Galvanizing and Terne	1	5	7	12
Cold Coating--Tin and Chrome	3	7	9	19
Plate	10	35	40	84
Subtotal	$ 159	$ 557	$ 872	$1,589
Storm Runoff*	1	17	87	104
Other Water*	28	182	635	846
GRAND TOTAL	$ 188	$ 756	$1,594	$2,539

*Includes changes in construction work in progress

**Less than .5 million

Source: PTm (Steel) projections

Exhibit C-6

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT IN SERVICE IN 1974 BY TIME PERIOD

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Material Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	1	1	1	4
Coke Oven	98	115	119	332
Ironmaking				
Blast Furnace	103	123	124	350
Steelmaking				
Open Hearth Furnace	3	3	2	7
Basic Oxygen Furnace	29	31	32	92
Electric Furnace	3	3	3	10
Vacuum Degassing	27	27	28	82
Casting and Forming				
Continuous Casting				
Billets and Blooms	8	8	9	25
Slabs	8	9	10	27
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	2	3	3	8
Breaking--Billets	1	2	2	5
Breaking--Slabs	6	7	8	21
Finishing Mills				
Heavy Structural	1	2	2	5
Hot Rolled Bar and Rod	40	49	53	142
Wire Product	10	10	10	29
Cold Finished Bar	7	8	9	24
Seamless Pipe and Tube	10	10	10	30
Hot Rolled Strip	29	36	38	104
Pickling and Oiling	236	282	299	818
Welded Pipe and Tube	13	13	13	38
Cold Rolled Strip	24	29	30	83
Hot Coating--Galvanizing and Terne	3	3	3	9
Cold Coating--Tin and Chrome	2	2	2	7
Plate	11	12	12	36
Subtotal	$ 676	$ 790	$ 822	$2,288
Storm Runoff	0	0	0	0
Other Water	0	0	0	0
GRAND TOTAL	$ 676	$ 790	$ 822	$2,288

Source: PTm (Steel) projections

Exhibit C-7

TOTAL* OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	1	2	2	5
Coke Oven	106	158	227	491
Ironmaking				
Blast Furnace	109	152	207	468
Steelmaking				
Open Hearth Furnace	3	3	3	8
Basic Oxygen Furance	31	39	43	112
Electric Furnace	4	5	6	14
Vacuum Degassing	38	60	85	183
Casting and Forming				
Continuous Casting				
Billets and Blooms	9	15	23	47
Slabs	10	18	27	55
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	5	12	14	31
Breaking--Billets	3	8	12	23
Breaking--Slabs	14	33	40	86
Finishing Mills				
Heavy Structural	3	3	14	24
Hot Rolled Bar and Rod	56	110	150	315
Wire Product	18	23	23	64
Cold Finished Bar	8	15	16	40
Seamless Pipe and Tube	14	22	25	61
Hot Rolled Strip	56	139	204	399
Pickling and Oiling	264	382	417	1063
Welded Pipe and Tube	27	39	41	108
Cold Rolled Strip	28	41	44	113
Hot Coating--Galvanizing and Terne	4	8	10	21
Cold Coating--Tin and Chrome	5	9	11	26
Plate	20	47	52	120
Subtotal	$ 835	$1,348	$1,694	$3,877
Storm Runoff	1	17	87	104
Other Water	28	182	635	846
GRAND TOTAL	$ 364	$1,547	$2,416	$4,827

*Includes water pollution control equipment in service prior to 1975

Source: PIm (Steel) projections

Exhibit C-8

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT INSTALLED 1975-1983 BY EFFLUENT GUIDELINE

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	BPCTCA	BATEA	NSPS	TOTAL
Raw Material Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	*	1	0	1
Coke Oven	45	84	30	158
Ironmaking				
Blast Furnace	38	67	11	117
Steelmaking				
Open Hearth Furnace	0	1	0	1
Basic Oxygen Furnace	7	2	11	20
Electric Furnace	1	1	2	4
Vacuum Degassing	15	42	44	101
Casting and Forming				
Continuous Casting				
Billets and Blooms	2	*	20	22
Slabs	2	1	25	28
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	21	2	0	23
Breaking--Billets	12	6	0	18
Breaking--Slabs	57	7	0	65
Finishing Mills				
Heavy Structural	12	7	0	19
Hot Rolled Bar and Rod	131	42	0	173
Wire Product	35	0	*	35
Cold Finished Bar	16	0	0	16
Seamless Pipe and Tube	27	3	2	31
Hot Rolled Strip	223	70	2	295
Pickling and Oiling	242	4	0	246
Welded Pipe and Tube	66	1	2	70
Cold Rolled Strip	30	0	0	30
Hot Coating--Galvanizing and Terne	9	1	2	12
Cold Coating--Tin and Chrome	15	3	1	19
Plate	78	0	6	84
Subtotal	$1,085	$ 347	$ 157	$1,589
Storm Runoff	0	0	0	104
Other Water	0	0	0	846
GRAND TOTAL	$1,085	$ 347	$ 157	$2,539

*Less than .5 million

Source: PTm (Steel) projections

Exhibit C-9

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT IN SERVICE IN 1974 BY EFFLUENT GUIDELINE

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	BPCTCA	BATEA	NSPS	TOTAL
Raw Material Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	4	*	0	4
Coke Oven	321	12	0	332
Ironmaking				
Blast Furnace	328	22	0	350
Steelmaking				
Open Hearth Furnace	7	0	0	7
Basic Oxygen Furnace	92	1	0	92
Electric Furnace	9	*	0	10
Vacuum Degassing	66	16	0	82
Casting and Forming				
Continuous Casting				
Billets and Blooms	23	2	0	25
Slabs	25	3	0	27
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	8	*	0	8
Breaking--Billets	4	1	0	5
Breaking--Slabs	21	1	0	21
Finishing Mills				
Heavy Structural	5	*	0	5
Hot Rolled Bar and Rod	141	1	0	142
Wire Product	29	0	0	29
Cold Finished Bar	24	0	0	24
Seamless Pipe and Tube	30	*	0	30
Hot Rolled Strip	97	8	0	104
Pickling and Oiling	817	1	0	818
Welded Pipe and Tube	38	*	0	38
Cold Rolled Strip	83	0	0	83
Hot Coating--Galvanizing and Terne	8	*	0	9
Cold Coating--Tin and Chrome	6	1	0	7
Plate	36	0	0	36
Subtotal	$2,219	$ 69	$ 0	$2,288
Storm Runoff	0	0	0	0
Other Water	0	0	0	0
GRAND TOTAL	$2,219	$ 69	$ 0	$2,288

*Less than .5 million

Source: PTm (Steel) projections

Exhibit C-10

TOTAL* OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY EFFLUENT GUIDELINE

NUS/CYRUS RICE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	BPCTCA	BATEA	NSPS	TOTAL
Raw Materials Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	4	1	0	5
Coke Ovens	365	96	30	491
Ironmaking				
Blast Furnace	367	90	11	468
Steelmaking				
Open Hearth Furnace	7	1	0	8
Basic Oxygen Furnace	99	3	11	113
Electric Furnace	11	1	2	14
Vacuum Degassing	81	58	44	183
Casting and Forming				
Continuous Casting				
Billets and Blooms	25	2	20	47
Slabs	27	3	26	55
Conventional Casting				
Ingot Casting	0	0	0	0
Breaking--Blooms	28	3	0	31
Breaking--Billets	16	7	0	23
Breaking--Slabs	78	8	0	86
Finishing Mills				
Heavy Structural	17	7	0	24
Hot Rolled Bar and Rod	272	43	0	314
Wire Product	64	0	**	64
Cold Finished Bar	40	0	0	40
Seamless Pipe and Tube	57	3	2	61
Hot Rolled Strip	319	78	2	399
Pickling and Oiling	1,058	5	0	1,063
Welded Pipe and Tube	104	1	2	108
Cold Rolled Strip	113	0	0	113
Hot Coating--Galvanizing and Terne	18	2	2	21
Cold Coating--Tin and Chrome	21	4	1	26
Plate	114	0	6	120
Subtotal	$3,304	$416	$157	$3,877
Storm Runoff***	0	0	0	104
Other Water***	0	0	0	846
GRAND TOTAL	$3,304	$416	$157	$4,827

*Includes water pollution control equipment in service prior to 1975

**Less than .5 million

***Includes changes in construction work in progress

Source: PTm (Steel) projections

Exhibit C-11

COMPARISON OF CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT NUS/CYRUS RICE VS. ARTHUR D. LITTLE ENGINEERING COST ESTIMATES

In-Place 1974 and Additions 1975-1983

(millions of 1975 dollars)

Process	NUS/Cyrus Rice Engineering Cost Estimates	Arthur D. Little Engineering Cost Estimates*
Raw Materials Preparation		
Ore Yard	$ 0	$ 0
Coal Yard	0	0
Scrap Yard	0	0
Sinter Strand	10	0
Coke Ovens	582	1,129
Ironmaking		
Blast Furnace	417	1,001
Steelmaking		
Open Hearth Furnace	19	58
Basic Oxygen Furnace	75	126
Electric Furnace	22	28
Vacuum Degassing	207	107
Casting and Forming		
Continuous Casting		
Billets and Blooms	118	53
Slabs	113	51
Conventional Casting		
Ingot Casting	0	0
Breaking--Blooms	75	82
Breaking--Billets	59	94
Breaking--Slabs	137	153
Finishing Mills		
Heavy Structural	65	75
Hot Rolled Bar and Rod	462	229
Wire Product	20	27
Cold Finished Bar	26	41
Seamless Pipe and Tube	39	23
Hot Rolled Strip	715	714
Pickling and Oiling	458	476
Welded Pipe and Tube	56	47
Cold Rolled Strip	104	154
Hot Coating--Galvanizing and Terne	40	21
Cold Coating--Tin and Chrome	36	18
Plate	131	58
TOTAL	$3,986	$4,765

*Without commingling

Source: PTm (Steel) projections

Exhibit C-12

COMPARISON OF TOTAL* OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT
NUS/CYRUS RICE VS. ARTHUR D. LITTLE ENGINEERING COST ESTIMATES
1975-1983
(millions of 1975 dollars)

Process	NUS/Cyrus Rice Engineering Cost Estimate	Arthur D. Little Engineering Cost Estimate**
Raw Materials Preparation		
Ore Yard	$ 0	$ 0
Coal Yard	0	0
Scrap Yard	0	0
Sinter Strand	5	0
Coke Ovens	491	1,088
Ironmaking		
Blast Furnace	468	1,238
Steelmaking		
Open Hearth Furnace	8	20
Basic Oxygen Furnace	113	153
Electric Furnace	14	28
Vacuum Degassing	183	18
Casting and Forming		
Continuous Casting		
Billets and Blooms	47	31
Slabs	55	36
Conventional Casting		
Ingot Casting	0	0
Breaking--Blooms	31	47
Breaking--Billets	23	69
Breaking--Slabs	86	117
Finishing Mills		
Heavy Structural	24	49
Hot Rolled Bar and Rod	315	156
Wire Product	64	28
Cold Finished Bar	40	52
Seamless Pipe and Tube	61	20
Hot Rolled Strip	399	533
Pickling and Oiling	1,063	336
Welded Pipe and Tube	108	42
Cold Rolled Strip	113	91
Hot Coating--Galvanizing and Terne	21	16
Cold Coating--Tin and Chrome	26	15
Plate	120	36
TOTAL	$3,877	$4,219

*Includes water pollution control equipment in service prior to 1976.

**Without commingling

Source: PTm (Steel) projections

APPENDIX D

COST IMPACT OF FEDERAL CLEAN AIR ACT AND OTHER AIR POLLUTION REGULATIONS

APPENDIX D

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APPENDIX D

LIST OF EXHIBITS

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D-1 Air Pollution Treatment Facilities In Place, 1974

Capital Expenditures for Air Pollution Control Equipment, Environmental Protection Agency Engineering Cost Estimates

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Operations and Maintenance Expenses for Air Pollution Control Equipment, Environmental Protection Agency Engineering Cost Estimates, 1975-1983

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D-11 Comparison of Operations and Maintenance Expenses For Air Pollution Control Equipment, Environmental Protection Agency Vs. Arthur D. Little Engineering Cost Estimates, 1975-1983

COST IMPACT OF FEDERAL CLEAN AIR ACT AND OTHER AIR POLLUTION REGULATIONS

COSTING METHODOLOGY

There are three methods which may be used to treat emissions from any production process. These are: fabric filters (baghouses), venturi scrubbers, and electrostatic precipitators (ESP).

Exhibit D-1 lists each process for which air emission control costs are contained in the "Cost of Clean Air" and the percent of capacity treated by each control method in 1974 and 1983 and thereafter. The amount of capacity treated by each method in 1974 is used to determine the value of capital expenditures already incurred. This value is for equipment installed at 1975 prices and thus may vary significantly from actual historical accounting data.

The proportion of capacity treated by each method was added incrementally for each process so that 100 percent of capacity for each process was treated for stack emissions by 1978. Fugitive emissions control equipment was added uniformly during the period 1978 to 1980 to all processes which were considered to require such control. It was assumed that no such controls are presently in use.

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT

Capital expenditures for air pollution control equipment expected to be placed into service during the

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

Projected operations and maintenance expenses associated with equipment placed into service during the 1975-1983 period are detailed by production process in Exhibit D-4. O&M expenses for equipment in service in 1974 are detailed in Exhibit D-5. The total O&M for all equipment to achieve air pollution control requirements is contained in Exhibit D-6.

Exhibit D-4 illustrates that coke ovens dominate O&M expenses even more greatly than they do capital expenditures. Coke ovens require O&M expenses of $1.3 billion, 62 percent of the total for all processes. The next largest process is blast furnace, which requires only 15 percent of the total. When O&M for equipment in service is added as in Exhibit D-6, coke ovens still represent 47 percent of the total.

COMPARISON WITH ARTHUR D. LITTLE ENGINEERING COST ESTIMATES

Comparisons of capital expenditures and O&M expenses using EPA and Arthur D. Little (ADL) engineering cost estimates are presented in Exhibits D-10 and D-11, respectively. In order to provide a comparable basis, the results using ADL engineering cost estimates use the baseline shipment forecast. Also both exhibits include costs for stack and fugitive emissions control. The ADL and the EPA engineering cost estimates lead to significantly different capital expenditures and O&M expenses, ADL being higher for some processes and EPA being higher for other processes.

Capital expenditures based upon ADL estimates are significantly higher for each of the iron and steelmaking furnaces. In addition, the ADL estimates contain costs for coal yard, casting and forming, and pickling and oiling which are not included in the "Cost of Clean Air" report. Total capital expenditures for these processes are $.1 billion.

Operations and Maintenance expenses vary between ADL and this report by processes even more greatly than do capital expenditures. Again, ADL estimates are significantly higher for all furnaces. However, ADL estimates for coke ovens are about 30 percent of Battelle estimates. ADL estimates of O&M for processes not included in the "Cost of Clean Air" report total $.1 billion.

A major reason for differences in air pollution control costs between EPA and ADL estimates is the cost of fugitive emissions control as discussed in Section 4 of this report.

Capital expenditures computed by PTm(Steel) using ADL engineering cost estimates are compared to figures from pages I-7 and VI-59 of their report in the table below:

COMPARISON OF CAPITAL EXPENDITURES
ARTHUR D. LITTLE REPORT VS. PTm(Steel) USING
ARTHUR D. LITTLE ENGINEERING COST ESTIMATES

(billions of 1975 dollars)

	ADL Report	PTm(Steel) ADL Engineering Cost Estimates
Stack	$2.52	n/a
Fugitive	2.94	n/a
	$5.46	$6.66
New Facilities		
- Additional Capacity	$1.42	*
	$6.68	$6.66
- Reworked Facilities	$1.42	0
TOTAL	$8.30	$6.66

---

*included above

n/a = not available

Since PTm(Steel) does not add pollution control equipment to reworked facilities, the correct comparison is at the level of stack plus fugitive plus additional capacity. PTm(Steel) results are within $.2 billion, or 3 percent, of the comparable figure from the ADL report.

Exhibit D-1A

AIR POLLUTION TREATMENT FACILITIES IN PLACE
1974
(percent of steel industry productive capacity)

Production Process	Type of Treatment Equipment Fabric Filter	 Electrostatic Precipitator	 Scrubber
Sinter			
Strand	6.3	0	0
Windbox	2.1	30.3	3.8
Coke Ovens	0	0	0
Open Hearth Furnace	0	70.1	9.1
Basic Oxygen Furnace	0	46.8	51.7
Electric Furnace	56.8	1.3	13.3

Source: Battelle Columbus Laboratories,
Cost of Clean Air (1974), Appendix C

Exhibit D-1B

AIR POLLUTION TREATMENT FACILITIES IN PLACE
1983
(percent of steel industry productive capacity)

Production Process	Type of Treatment Equipment		
	Fabric Filter	Electrostatic Precipitator	Scrubber
Sinter			
Strand	100.0		
Windbox	2.3	94.1	3.6
Coke Ovens			100.0
Open Hearth Furnace	0	90.8	9.2
Basic Oxygen Furnace	0	66.1	33.9
Electric Furnace	83.3	1.4	15.3

Source: Battelle Columbus Laboratories,
Cost of Clean Air (1974), Appendix C

Exhibit D-2

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

ENVIRONMENTAL PROTECTION AGENCY[1] ENGINEERING COST ESTIMATES

(millions of 1975 dollars)

Process	In-Place 1974	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation					
Ore Yard	$ 0	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0	0
Scrap Yard	0	0	0	0	0
Sinter Strand	0	53	40	0	93
Coke Ovens	0	583	635	57	1,275
Ironmaking					
Blast Furnace	0	0	356	14	370
Steelmaking					
Open Hearth Furnace	267	0	139	0	139
Basic Oxygen Furnace	181	78	109	33	220
Electric Furnace	229	191	231	101	523
Vacuum Degassing	0	0	0	0	0
Subtotal	$677	$ 905	$1,510	$205	$2,620
Changes in Construction Work in Progress	0	1,050	(690)	11	371
Total	$677	$1,955	$ 820	$216	$2,991
Other Air[2]	0	133	84	42	259
GRAND TOTAL	$677	$2,088	$ 904	$258	$3,249

---

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

[2] Includes Construction Work in Progress

Source: PTm (Steel) projections

Exhibit D-3

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY TYPE OF CONTROL

ENVIRONMENTAL PROTECTION AGENCY[1] ENGINEERING COST ESTIMATES
1975-1983
(millions of 1975 dollars)

Process	Stack	Fugitive	Total
Raw Materials Preparation			
Ore Yard	$ 0	$ 0	$ 0
Coal Yard	0	0	0
Scrap Yard	0	0	0
Sinter Strand	68	24	92
Coke Ovens	859	416	1,275
Ironmaking			
Blast Furnace	0	370	370
Steelmaking			
Open Hearth Furnace	0	139	139
Basic Oxygen Furnace	151	69	220
Electric Furnace	344	178	522
Vacuum Degassing	0	0	0
Subtotal	$1,421	$1,198	$2,619
Changes in Construction Work in Progress	229	142	371
Total	$1,650	$1,340	$2,990
Other Air[2]	0	0	259
GRAND TOTAL	$1,650	$1,340	$3,249

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

[2] Includes Construction Work in Progress

Source: PTm (Steel) projections

Exhibit D-4

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT INSTALLED 1975-1983 BY TIME PERIOD

ENVIRONMENTAL PROTECTION AGENCY[1] ENGINEERING COST ESTIMATES 1975-1983

(millions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	20	50	56	126
Coke Ovens	155	524	627	1,306
Ironmaking				
Blast Furnace	0	124	195	319
Steelmaking				
Open Hearth Furnace	0	47	71	118
Basic Oxygen Furnace	*	14	28	43
Electric Furnace	11	77	115	202
Vacuum Degassing	0	0	0	0
Subtotal	$186	$836	$1,093	$2,115
Other Air	22	70	131	222
GRAND TOTAL	$208	$906	$1,224	$2,336

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* Less than $0.5 million

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit D-5

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT IN SERVICE IN 1974 BY TIME PERIOD

ENVIRONMENTAL PROTECTION AGENCY[1] ENGINEERING COST ESTIMATES
1975-1983

(millions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	12	18	19	51
Coke Ovens	0	0	0	0
Ironmaking				
Blast Furnace	0	0	0	0
Steelmaking				
Open Hearth Furnace	31	29	24	84
Basic Oxygen Furnace	131	139	138	407
Electric Furnace	42	43	43	128
Vacuum Degassing	0	0	0	0
Subtotal	$218	$228	$223	$670
Other Air	0	0	0	0
GRAND TOTAL	$218	$228	$223	$670

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit D-6

TOTAL OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD[1]

ENVIRONMENTAL PROTECTION AGENCY[2] ENGINEERING COST ESTIMATES
1975-1983

(millions of 1975 dollars)

Process	1975-1977	1978-1980	1981-1983	1975-1983
Raw Materials Preparation				
Ore Yard	$ 0	$ 0	$ 0	$ 0
Coal Yard	0	0	0	0
Scrap Yard	0	0	0	0
Sinter Strand	34	68	75	177
Coke Ovens	155	524	627	1,306
Ironmaking				
Blast Furnace	0	124	195	319
Steelmaking				
Open Hearth Furnace	31	76	95	202
Basic Oxygen Furnace	131	153	166	450
Electric Furnace	52	120	158	330
Vacuum Degassing	0	0	0	0
Subtotal	$404	$1,064	$1,316	$2,784
Other Air	22	70	131	222
GRAND TOTAL	$426	$1,134	$1,447	$3,006

[1] Includes air pollution control equipment in service prior to 1975

[2] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies.

Source: PTm (Steel) projections

Exhibit D-7

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT INSTALLED 1975-1983 BY TYPE OF CONTROL

ENVIRONMENTAL PROTECTION AGENCY[1] ENGINEERING COST ESTIMATES
1975-1983

(millions of 1975 dollars)

Process	Stack	Fugitive	Total
Raw Materials Preparation			
Ore Yard	$ 0	$ 0	$ 0
Coal Yard	0	0	0
Scrap Yard	0	0	0
Sinter Strand	109	16	125
Coke Ovens	825	481	1,306
Ironmaking			
Blast Furnace	0	319	319
Steelmaking			
Open Hearth Furnace	0	118	118
Basic Oxygen Furnace	(14)	58	44
Electric Furnace	43	159	202
Vacuum Degassing	0	0	0
Subtotal	$963	$1,151	$2,114
Other Air	0	0	222
GRAND TOTAL	$963	$1,151	$2,336

---

[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit D-8

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT IN SERVICE IN 1974 BY TYPE OF CONTROL

ENVIRONMENTAL PROTECTION AGENCY[1] ENGINEERING COST ESTIMATES

(millions of 1975 dollars)

Process	Stack	Fugitive	Total
Raw Materials Preparation			
Ore Yard	$ 0	$0	$ 0
Coal Yard	0	0	0
Scrap Yard	0	0	0
Sinter Strand	51	0	51
Coke Ovens	0	0	0
Ironmaking			
Blast Furnace	0	0	0
Steelmaking			
Open Hearth Furnace	84	0	84
Basic Oxygen Furnace	407	0	407
Electric Furnace	128	0	128
Vacuum Degassing	0	0	0
Subtotal	$670	$0	$670
Other Air	0	0	0
GRAND TOTAL	$670	$0	$670

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit D-9

TOTAL OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY TYPE OF CONTROL[1]

ENVIRONMENTAL PROTECTION AGENCY[2] ENGINEERING COST ESTIMATES
1975-1983
(millions of 1975 dollars)

Process	Stack	Fugitive	Total
Raw Materials Preparation			
Ore Yard	$ 0	$ 0	$ 0
Coal Yard	0	0	0
Scrap Yard	0	0	0
Sinter Strand	160	16	176
Coke Ovens	825	481	1,306
Ironmaking			
Blast Furnace	0	319	319
Steelmaking			
Open Hearth Furnace	84	118	202
Basic Oxygen Furnace	393	58	450
Electric Furnace	171	159	330
Vacuum Degassing	0	0	0
Subtotal	$1,633	$1,151	$2,784
Other Air	0	0	222
GRAND TOTAL	$1,633	$1,151	$3,006

[1] Includes air pollution control equipment in service prior to 1975

[2] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit D-10

COMPARISON OF CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT IN-PLACE 1974 AND ADDITIONS

ENVIRONMENTAL PROTECTION AGENCY[1] VS. ARTHUR D. LITTLE ENGINEERING COST ESTIMATES

(millions of 1975 dollars)

Process	Environmental Protection Agency Engineering Cost Estimates	Arthur D. Little Engineering Cost Estimates
Raw Materials Preparation		
Ore Yard	$ 0	$ 0
Coal Yard	0	23
Scrap Yard	0	0
Sinter Strand	97	398
Coke Ovens	1,275	1,164
Ironmaking		
Blast Furnace	370	816
Steelmaking		
Open Hearth Furnace	406	1,700
Basic Oxygen Furnace	401	1,156
Electric Furnace	752	1,304
Vacuum Degassing	0	0
Casting and Forming		
Continuous Casting		
Billets and Blooms	0	13
Slabs	0	6
Conventional Casting		
Ingot Casting	0	0
Breaking--Blooms	0	19
Breaking--Billets	0	22
Breaking--Slabs	0	33
Finishing Mills		
Heavy Structural	0	0
Hot Rolled Bar and Rod	0	0
Wire Product	0	0
Cold Finished Bar	0	0
Seamless Pipe and Tube	0	0
Hot Rolled Strip	0	0
Pickling and Oiling	0	8
Welded Pipe and Tube	0	0
Cold Rolled Strip	0	0
Hot Coating--Galvanizing and Terne	0	0
Cold Coating--Tin and Chrome	0	0
Plate	0	0
TOTAL	$3,301	$6,663

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

Exhibit D-11

COMPARISON OF TOTAL OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

ENVIRONMENTAL PROTECTION AGENCY[1] VS. ARTHUR D. LITTLE ENGINEERING COST ESTIMATES

1975-1983

(millions of 1975 dollars)

Process	Environmental Protection Agency Engineering Cost Estimates	Arthur D. Little Engineering Cost Estimates
Raw Materials Preparation		
Ore Yard	$ 0	$ 0
Coal Yard	0	20
Scrap Yard	0	0
Sinter Strand	176	214
Coke Ovens	1,306	370
Ironmaking		
Blast Furnace	319	742
Steelmaking		
Open Hearth Furnace	202	998
Basic Oxygen Furnace	450	1,162
Electric Furnace	330	1,477
Vacuum Degassing	0	0
Casting and Forming		
Continuous Casting		
Billets and Blooms	0	16
Slabs	0	
Conventional Casting		
Ingot Casting	0	0
Breaking--Blooms	0	10
Breaking--Billets	0	12
Breaking--Slabs	0	32
Finishing Mills		
Heavy Structural	0	0
Hot Rolled Bar and Rod	0	0
Wire Product	0	0
Cold Finished Bar	0	0
Seamless Pipe and Tube	0	0
Hot Rolled Strip	0	0
Pickling and Oiling	0	4
Welded Pipe and Tube	0	0
Cold Rolled Strip	0	0
Hot Coating--Galvanizing and Terne	0	0
Cold Coating--Tin and Chrome	0	0
Plate	0	0
TOTAL	$2,784	$5,057

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[1] Report submitted to EPA by Battelle Columbus Laboratories, Cost of Clean Air (1974), Appendix C; plus internal EPA staff studies

Source: PTm (Steel) projections

APPENDIX E

ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS:

REVENUE REQUIREMENTS, PRICE EFFECTS, AND EXTERNAL FINANCING NEEDS

APPENDIX E

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ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS: REVENUE REQUIREMENTS, PRICE EFFECTS, AND EXTERNAL FINANCING NEEDS

Sections 6 and 7 of the report provide summary findings regarding the economic effects of environmental regulations. These effects are examined in terms of required revenues, prices and external financing needs for the steel industry as modeled. This Appendix supplements Sections 6 and 7 by presenting the findings in more detail.

REVENUE REQUIREMENTS AND PRICE EFFECTS

The required revenues and price effects associated with pollution control requirements indicate the impacts of these policies on the consumers of steel industry products. Required revenues and price effects attributable to each steel process and product are displayed in Exhibits E-1 through E-4. Revenue requirements are shown by process and product for the baseline conditions and for air and water pollution control. These revenue requirements exhibits supplement Exhibit 22 in the main body of the report. Price effects are shown by process and product for each level of the water pollution guidelines. These exhibits supplement Exhibits 24 and 26 in the report.

The effects of using alternative basic raw materials costs in the determination of baseline revenue requirements and prices are shown in Exhibit E-5. The alternative raw materials costs presented are those provided by Data Resources, Inc. (DRI) through the DRI Steel Forecast Service (Summer 1975). For both required revenues and prices, use of the DRI materials costs causes a significant decline in both the short and long term. As shown in Exhibit E-5, 1975-1983 average revenues per ton dropped from $365.21 to $313.35, or 9 percent if the DRI cost forecasts are used.

The revenue effects of not allowing the recovery of costs associated with air and water pollution control from steel consumers are shown in Exhibit E-6. Relative to the full cost pass-through situation shown in Exhibits 21 and 23, this results in lower required revenues and prices. The reduction in total required revenues if no pollution control-related expenses including those for equipment now in place are passed-through equals 4.6 percent, and reduces net income to 2 percent return on equity.

The sensitivity of required revenues and prices to alternative rates of return on equity is shown in Exhibits E-7 and E-8. Exhibit E-7 shows the effects on required revenues and prices if the steel industry were to earn the same real rate of return as that achieved by all manufacturing firms during the last decade. This real return equals 7 percent. Comparison of Exhibit E-7 with Exhibits 22 and 23 in the main report shows that, in order to earn the manufacturing rate of return, baseline revenues over the period will need to rise by 2.5 percent. Over the same period, required revenues associated with air and water pollution control will need to increase by approximately 11 percent to achieve this return. These increases in required revenues will cause similar increases in the average price for steel products. By 1983 baseline prices like the corresponding revenue requirements will need to increase by 2.5 percent. Price increases associated with water and air pollution will need to be 5.0 percent, an increase of 8.2 percent over the 4.6 percent required at the baseline rate of return. The combined result of these increases is an increase of 2.7 percent in the total 1983 average price for steel products.

Exhibit E-8 shows the effects on required revenues and prices if the steel industry were to earn to same real rate of return as that achieved by major steel producers on their steel operations only. As detailed in Section 6 of the report, the real rate achieved on steel operations by major integrated producers was minus 1 percent over the 1972 to 1974 period. Achievement of only this rate of return would result in substantial decreases in both required revenues and prices, as can be seen by a comparison of Exhibit E-8 with Exhibits 22 and 23 in the main report. Using the steel operations rate of return, total required revenues over the period from 1975 to 1983 and the 1983 average price of steel both drop by approximately 3.5 percent.

EXTERNAL FINANCING NEEDS

An important parameter used to measure the economic effect of pollution control regulations is the external financing required by the industry. Requirements for external financing based on different levels of pollution control and on sensitivity to external conditions and assumptions are determined. These effects of the factors on the industry's flow of funds are shown by use of industry flow of funds statements for the short (1975-1977) and long (1975-1983) term. Applications of funds in these exhibits include capital expenditures both for plant and equipment placed in service and plant and equipment under construction during the period, changes in working capital, and refundings of long-term debt. Sources of funds can be separated into internal sources, namely depreciation (and other non-cash charges) and retained earnings; and external sources, namely, new issues of long-term debt and common equity. (Note: This analysis assumes no issues of preferred stock.)

Additional detail concerning the external financing effects of pollution control guidelines is shown in Exhibits E-9 through E-16. These flow of funds statements show the basic data underlying the water and air pollution control columns in Exhibits 27 and 28 of the main report. Exhibits E-9 and E-10 display the total short- and long-term funds flow associated with the process-level water pollution guidelines. Exhibits E-11 and E-12 show similar data for Phase I processes only. The differences between Exhibits E-11 or E-12 and Exhibits E-9 or E-10, respectively, are due to costs for Phase II processes.

Exhibits E-13 and E-14 present the sources and applications of funds for non-process related water pollution control. Non-process pollution control requirements include storm run-off as mandated by the BATEA guideline, effluent streams from ancillary equipment, non-contact cooling water, and thermal pollution. The sum of the total columns from the non-process and the process-related water pollution control exhibits will yield the total water pollution control costs displayed in Exhibits 27 and 28 of the report.

Exhibits E-15 and E-16 display the funds flows by air pollution standard for the short and long term. All of these flows are associated with Phase I processes, with the exception of those for ancillary equipment, which are not process-related. The total columns in Exhibits E-15 and E-16 correspond to the air pollution columns in Exhibits 27 and 28 of the report.

The sources and applications of funds associated with different levels of steel shipments are displayed in Exhibits E-17 through E-22. These exhibits provide the basic data for the sensitivity analysis of steel demand discussed in section 7. These exhibits can be compared with Exhibits 27 and 28 in the report to identify the effects of alternative demand scenarios.

The flow of funds associated with planning under uncertainty are shown in Exhibits E-23 to E-26. These exhibits show the financial effects of steel demand which is either above or below the planned level of capacity additions. Although capital expenditures remain the same as in the baseline conditions, differences in working capital and retained earnings resulting from different levels of capacity utilization and unit costs do effect the flow of of funds. These changes in turn effect the amount of external financing required by the industry. Exhibits E-23 to E-26 can be compared with Exhibits 27 and 28 to demonstrate the effects of future steel demand levels different from the baseline assumptions.

The financial effects of alternative rates of return on equity are shown in Exhibits E-27 through E-30. Levels of working capital, retained earnings and external financing are altered by the achievement of either the all-manufacturing average return or the steel operations-only return. These effects are discussed in section 7 of the report and can be developed in detail by comparing the appendix exhibits with Exhibits 27 and 28.

In addition to the alternative rates of return analysis outlined above, the financial implications of a higher cost of both equity and debt capital were analyzed in the report. The flow of funds data for this analysis are displayed in Exhibits E-31 and E-32. These exhibits display the differential effects of a 1 percent increase in both the real return to equity and the real interest rate for long-term debt issues.

Exhibits E-33 through E-36 display the full funds flow statements for alternative BPCTCA compliance schedules. These exhibits can be compared with Exhibits E-9 and E-10 in order to develop the full financial impact of alternative BPCTCA compliance dates.

Exhibits E-37 and E-38 show the external financing effects of zero cost pass-through. These effects are shown by use of funds flow statements for the industry. The funds flow statements for zero cost pass-through can be compared with Exhibits 27 and 28. Such a comparison shows that, in the long term, cumulative retained earnings are reduced from $7.1 billion to $2.6 billion with zero cost pass-through, a reduction of 64.1 percent. This reduction results from a decrease in net income discussed, To offset the decline in retained earnings, issues of common equity would have to be increased from $9.9 billion to $14.5 billion, a 46.1 percent increase.

Exhibit E-1

REVENUE REQUIREMENTS BY PROCESS
1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	$45.87	$.03	-	$45.91
Coal Yard	35.94	.01	-	35.95
Scrap Yard	73.74	.01	-	73.75
Sinter Strand	3.79	.02	.37	4.18
Coke Oven	2.11	.45	1.89	4.44
Iron Making				
Blast Furnace	7.73	.48	.49	8.70
Steel Making				
Open Hearth Furnace	12.64	.09	1.26	13.99
Basic Oxygen Furnace	24.91	.23	.41	25.55
Electric Furnace	16.38	.09	1.27	17.75
Vacuum Degassing	.20	.15	-	.35
Casting and Forming Continuous Casting				
Billets and Blooms	1.15	.05	-	1.20
Slabs	5.99	.09	-	6.08
Conventional Casting				
Ingot Casting	5.24	.04	-	5.28
Breaking - Blooms	4.00	.14	-	4.14
Breaking - Billets	6.61	.23	-	6.84
Breaking - Slabs	5.03	.34	-	5.37
Finishing Mills				
Heavy Structural	1.52	.08	-	1.60
Hot Rolled Bar and Rod	11.30	.59	-	11.89
Wire Product	3.60	.11	-	3.71
Cold Finished Bar	.03	.03	-	.06
Seamless Pipe and Tube	2.48	.09	-	2.57
Hot Rolled Strip	22.52	.85	-	23.37
Pickling and Oiling	6.61	.57	-	7.18
Welded Pipe and Tube	4.05	.13	-	4.18
Cold Rolled Strip	18.01	.45	-	18.47
Hot Coating - Galvanizing and Terne	3.85	.08	-	3.94
Cold Coating - Tin and Chrome	6.34	.12	-	6.45
Plate	6.98	.19	-	7.17
Total	338.61	5.75	5.68	350.04

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[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-2

REVENUE REQUIREMENTS BY STEEL PRODUCT
1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Steel Product				
Direct Shipments of Ingots, Blooms, Billets and Slabs	$ 8.96	$ .08	$ .15	$ 9.19
Heavy Structurals and Rails	20.94	.26	.37	21.57
Nails and Wire Products	12.87	.27	.21	13.35
Bars and Light Structurals	50.60	.93	.93	52.46
Cold Finished Bars	6.13	.14	.11	6.38
Seamless Pipe and Tubing	10.90	.18	.18	11.26
Welded Pipe	21.50	.42	.33	22.25
Hot Rolled Sheet and Strip	42.65	.64	.73	44.02
Galvanized Products	26.69	.50	.44	27.63
Tin and Other Plated Products	32.43	.58	.51	33.52
Cold Rolled Sheet and Strip	73.90	1.32	1.26	76.47
Plates	31.06	.41	.47	31.94
Total	$338.61	$5.75	$5.68	$350.04

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-3

PRICE EFFECTS FOR WATER POLLUTION GUIDELINES BY PROCESS
1983
(1975 dollars per ton of unit operation output)

	BPCTCA	BATEA	NSPS	Other[1]	Total
Raw Materials Preparation					
Ore Yard	-	.01	-	.02	.03
Coal Yard	.01	-	-	.02	.03
Scrap Yard	.01	-	-	.02	.03
Sinter Strand	.02	.03	-	.08	.13
Coke Oven	.26	.67	.18	.55	1.66
Iron Making					
Blast Furnace	.18	.34	.07	.38	97
Steel Making					
Open Hearth Furnace	.13	.14	.05	.54	.86
Basic Oxygen Furnace	.07	.07	.05	.23	.42
Electric Furnace	.07	.08	.04	.29	.48
Vacuum Degassing	.07	.27	.23	.03	.60
Casting and Forming Continuous Casting					
Billets and Blooms	.05	.03	.64	.10	.82
Slabs	.08	.06	.50	.26	.90
Conventional Casting					
Ingot Casting	.01	.01	.01	.03	.06
Breaking - Blooms	.38	.20	.05	.55	1.18
Breaking - Billets	.36	.36	.09	.98	1.79
Breaking - Slabs	.29	.15	.04	.43	.91
Finishing Mills					
Heavy Structural	.49	.61	.05	.60	1.75
Hot Rolled Bar and Rod	1.65	1.43	.13	1.54	4.75
Wire Product	2.44	.55	.26	2.51	5.76
Cold Finished Bar	1.63	.01	-	.03	1.67
Seamless Pipe and Tube	1.91	.79	.33	1.75	4.78
Hot Rolled Strip	.86	.73	.09	.67	2.35
Pickling and Oiling	1.10	.12	.03	.39	1.64
Welded Pipe and Tube	1.93	.26	.21	.87	3.27
Cold Rolled Strip	.50	.30	.12	1.37	2.29
Hot Coating - Galvanizing and Terne	.60	.35	.21	1.10	2.26
Cold Coating - Tin and Chrome	.76	.49	.19	1.47	2.91
Plate	1.79	.16	.29	.72	2.96

[1] Includes storm runoff, ancillary water, cooling water blowdown, and thermal treatments

Source: PTm(Steel)

Exhibit E-4

PRICE EFFECTS FOR WATER POLLUTION GUIDELINES BY STEEL PRODUCT
1983

(1975 dollars per ton of steel product)

Steel Product	BPCTCA	BATEA	NSPS	Other[1]	Total
Direct Shipments of Ingots, Blooms, Billets and Slabs	.63	.89	.44	1.40	3.36
Heavy Structurals and Rails	1.30	1.68	.61	2.25	5.84
Nails and Wire Products	5.13	3.39	1.11	6.43	16.06
Bars and Light Structurals	2.56	2.70	.82	3.73	9.81
Cold Finished Bars	4.19	2.71	.82	3.75	11.47
Seamless Pipe and Tubing	2.92	2.14	1.06	4.13	10.25
Welded Pipe	4.95	2.36	.90	3.78	11.99
Hot Rolled Sheet and Strip	2.03	1.76	.58	2.32	6.69
Galvanized Products	4.33	2.92	1.07	5.63	13.95
Tin and Other Plated Products	4.50	3.04	1.06	6.00	14.60
Cold Rolled Sheet and Strip	3.59	2.47	.82	4.36	11.24
Plates	2.59	1.29	.84	2.45	7.17

[1] Includes storm runoff, ancillary water, cooling water blowdown, and thermal treatment.

Source: PTm(Steel)

Exhibit E-5

EFFECT ON REQUIRED REVENUES AND PRICE OF ALTERNATIVE BASIC RAW MATERIALS COSTS

	DRI RAW MATERIALS PRICE FORECASTS		BASELINE RAW MATERIALS PRICE FORECASTS	
	1975-1977	1975-1983	1975-1977	1975-1983
Required Revenues for production and 1974 in-place pollution control (billions of 1975 dollars)	$ 90.41	$305.55	$ 96.11	$338.61
Average end-of-period price based on production and 1974 in-place pollution control (1975 dollars per ton of steel product)	$317.38	$313.35	$345.28	$365.21

Source: PTm(Steel)

Exhibit E-6

EFFECT ON REQUIRED REVENUES AND PRICE OF ZERO COST PASS-THROUGH OF POLLUTION CONTROL COSTS

	Production and In-Place Pollution Control Equipment	Pollution Control Equipment		Total
		Water	Air	
Required Revenues, 1975-1983 (billions of 1975 dollars)	$334.06	$(.07)	$(.09)	$333.90
Price in 1983 (1975 dollars per ton)	$361.49	$(.54)	$(.27)	$360.68

Source: PTm(Steel)

Exhibit E-7

EFFECT ON REQUIRED REVENUES AND PRICE OF ALL MANUFACTURING RETURN ON EQUITY OF POLLUTION CONTROL COSTS

	Production and In-Place Pollution Control Equipment	Pollution Control Equipment		Total
		Water	Air	
Required Revenues (1975-1983) (billions of 1975 dollars)	$347.03	$ 6.36	$6.32	$359.71
Price in 1983 (1975 dollars per ton of product)	$374.28	$10.38	$7.79	$392.45

Source: PTm(Steel)

Exhibit E-8

EFFECT ON REQUIRED REVENUES AND PRICE OF STEEL OPERATIONS RETURN ON EQUITY OF POLLUTION CONTROL COSTS

	Production and In-Place Pollution Control Equipment	Pollution Control Equipment		
		Water	Air	Total
Required Revenues (1975-1983) (billions of 1975 dollars)	$327.80	$4.98	$4.89	$337.67
Price in 1983 (1975 dollars per ton of product)	$353.72	$8.60	$6.34	$368.66

Source: PTm(Steel)

Exhibit E-9

SOURCES AND APPLICATIONS OF FUNDS FOR PROCESS EFFLUENT GUIDELINES 1975-1977

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$1.34	$.13	$.11	$1.58
Changes in Working Capital	.02	0	0	.02
Total Applications	$1.36	$.13	$.11	$1.60
Sources of Funds				
Depreciation	$ .06	$0	$0	$ .07
Retained Earnings	.10	.01	.01	.11
Subtotal--Internal Sources	$ .16	$.01	$.01	$ .18
Issues of Long-Term Debt	$ .33	$.03	$.03	$ .39
Issues of Common Stock	.87	.09	.08	1.03
Subtotal--External Financing	$1.20	$.12	$.11	$1.42
Total Sources	$1.36	$.13	$.11	$1.60

Source: PTm(Steel)

Exhibit E-10

SOURCES AND APPLICATIONS OF FUNDS FOR PROCESS EFFLUENT GUIDELINES
1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$1.54	$.87	$.41	$2.83
Changes in Working Capital	.07	.05	.02	.14
Total Applications	$1.62	$.92	$.43	$2.96
Sources of Funds				
Depreciation	$ .51	$.13	$.06	$ .70
Retained Earnings	.27	.08	.04	.39
Subtotal--Internal Sources	$ .78	$.21	$.10	$1.09
Issues of Long-Term Debt	$ .28	$.20	$.09	$ .58
Issues of Common Stock	.56	.51	.23	1.30
Subtotal--External Financing	$ .84	$.71	$.33	$1.87
Total Sources	$1.62	$.92	$.43	$2.96

Source: PTm(Steel)

Exhibit E-11

SOURCES AND APPLICATIONS OF FUNDS FOR PROCESS EFFLUENT GUIDELINES (PHASE I ONLY)
1975-1977

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$ .12	$.04	$.10	$.26
Changes in Working Capital	*	0	0	*
Total Applications	$ .13	$.04	$.10	$.27
Sources of Funds				
Depreciation	$ .01	*	*	$.01
Retained Earnings	.01	*	*	.02
Subtotal--Internal Sources	$ .02	*	$.01	$.03
Issues of Long-Term Debt	$ .03	$.01	$.03	$.07
Issues of Common Stock	.08	.02	.07	.17
Subtotal--External Financing	$ .11	$.03	$.10	$.24
Total Sources	$ .13	$.04	$.10	$.27

*slightly less than $.005 billion

Source: PTm(Steel)

Exhibit E-12

SOURCES AND APPLICATIONS OF FUNDS FOR PROCESS EFFLUENT GUIDELINES (PHASE I ONLY)
1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$.14	$.19	$.32	$.65
Changes in Working Capital	.01	.02	.01	.04
Total Applications	$.14	$.21	$.34	$.68
Sources of Funds				
Depreciation	$.05	$.03	$.05	$.13
Retained Earnings	.03	.02	.03	.08
Subtotal--Internal Sources	$.07	$.05	$.09	$.21
Issues of Long-Term Debt	$.03	$.04	$.07	$.14
Issues of Common Stock	.05	.11	.18	.34
Subtotal--External Financing	$.07	$.16	$.25	$.48
Total Sources	$.14	$.21	$.34	$.68

Source: PTm(Steel)

Exhibit E-13

SOURCES AND APPLICATIONS OF FUNDS FOR NON-PROCESS WATER POLLUTION CONTROL
1975-1977

(billions of 1975 dollars)

	Storm Runoff	Ancillary Water	Cooling Water Blowdown	Thermal	Total
Applications of Funds					
Capital Expenditures	$.02	$.04	$.07	$.05	$.18
Changes in Working Capital	0	0	0	0	0
Total Applications	$.02	$.04	$.07	$.05	$.18
Sources of Funds					
Depreciation	$0	$*	$*	$0	$.01
Retained Earnings	0	*	*	0	.01
Subtotal--Internal Sources	$0	$.01	$.01	$0	$.01
Issues of Long-Term Debt	$.01	$.01	$.02	$.01	$.05
Issues of Common Stock	.01	.02	.05	.04	.12
Subtotal--External Financing	$.02	$.03	$.06	$.05	$.16
Total Sources	$.02	$.04	$.07	$.05	$.18

*slightly less than $.005 billion

Source: PTm(Steel)

Exhibit E-14

SOURCES AND APPLICATIONS OF FUNDS FOR NON-PROCESS WATER POLLUTION CONTROL 1975-1983

(billions of 1975 dollars)

	Storm Runoff	Ancillary Water	Cooling Water Blowdown	Thermal	Total
Applications of Funds					
Capital Expenditures	$.15	$.05	$.12	$.43	$.75
Changes in Working Capital	.01	.01	.02	.05	.08
Total Applications	$.16	$.05	$.14	$.48	$.82
Sources of Funds					
Depreciation	$.02	$.01	$.03	$.06	$.13
Retained Earnings	.01	.01	.02	.04	.08
Subtotal--Internal Sources	$.03	$.02	$.05	$.10	$.21
Issues of Long-Term Debt	$.04	$.01	$.03	$.11	$.18
Issues of Common Stock	.09	.02	.06	.27	.44
Subtotal--External Financing	$.12	$.03	$.09	$.38	$.62
Total Sources	$.16	$.05	$.14	$.48	$.82

Source: PTm(Steel)

Exhibit E-15

SOURCES AND APPLICATIONS OF FUNDS FOR AIR POLLUTION CONTROL
1975-1977

(billions of 1975 dollars)

	Emission Standard			
	Stack Emissions	Fugitive Emissions	Ancillary Air	Total
Applications of Funds				
Capital Expenditures	$1.33	$.63	$.13	$2.09
Changes in Working Capital	.03	.01	.01	.04
Total Applications	$1.36	$.63	$.14	$2.13
Sources of Funds				
Depreciation	$ .08	$ 0	$.01	$ .09
Retained Earnings	.12	.02	.01	.14
Subtotal--Internal Sources	$ .20	$.02	$.02	$ .23
Issues of Long-Term Debt	$ .33	$.17	$.03	$ .53
Issues of Common Stock	.84	.45	.08	1.37
Subtotal--External Financing	$1.16	$.62	$.12	$1.90
Total Sources	$1.36	$.63	$.14	$2.13

Source: PTm(Steel)

Exhibit E-16

SOURCES AND APPLICATIONS OF FUNDS FOR AIR POLLUTION CONTROL
1975-1983

(billions of 1975 dollars)

	Emission Standard			Total
	Stack Emissions	Fugitive Emissions	Ancillary Air	
Applications of Funds				
Capital Expenditures	$1.65	$1.34	$.26	$3.25
Changes in Working Capital	.07	.10	.02	.19
Total Applications	$1.72	$1.44	$.28	$3.44
Sources of Funds				
Depreciation	$ .51	$ .32	$.06	$ .90
Retained Earnings	.28	.17	.04	.48
Subtotal--Internal Sources	$ .79	$ .49	$.10	$1.38
Issues of Long-Term Debt	$ .31	$ .30	$.06	$ .66
Issues of Common Stock	.62	.65	.12	1.40
Subtotal--External Financing	$ .93	$ .95	$.18	$2.06
Total Sources	$1.72	$1.44	$.28	$3.44

Source: PTm(Steel)

Exhibit E-17

SOURCES AND APPLICATIONS OF FUNDS FOR OPTIMISTIC DEMAND 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$12.95	$1.89	$2.28	$17.12
Changes in Working Capital	1.17	.05	.06	1.28
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$14.59	$1.94	$2.34	$18.87
Sources of Funds				
Depreciation	$ 4.31	$ .07	$ .09	$ 4.47
Retained Earnings	2.46	.14	.17	2.77
Subtotal--Internal Sources	$ 6.77	$ .21	$ .26	$ 7.24
Issues of Long-Term Debt	$ 3.40	$ .48	$ .57	$ 4.45
Issues of Common Stock	4.42	1.25	1.51	7.18
Subtotal--External Financing	$ 7.82	$1.73	$2.08	$11.63
Total Sources	$14.59	$1.94	$2.34	$18.87

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[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-18

SOURCES AND APPLICATIONS OF FUNDS FOR OPTIMISTIC DEMAND
1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$35.48	$3.85	$3.55	$42.88
Changes in Working Capital	5.09	.25	.22	5.55
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$41.78	$4.11	$3.77	$49.65
Sources of Funds				
Depreciation	$15.26	$ .89	$ .97	$17.12
Retained Earnings	7.33	.52	.54	8.39
Subtotal--Internal Sources	$22.59	$1.41	$1.52	$25.51
Issues of Long-Term Debt	$ 8.10	$ .82	$ .71	$ 9.63
Issues of Common Stock	$11.09	$1.88	$1.54	$14.52
Subtotal--External Financing	$19.19	$2.70	$2.25	$24.15
Total Sources	$41.78	$4.11	$3.77	$49.65

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-19

SOURCES AND APPLICATIONS OF FUNDS FOR PESSIMISTIC DEMAND 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$6.63	$1.69	$1.92	$10.24
Changes in Working Capital	1.27	.02	.03	1.32
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$8.37	$1.71	$1.96	$12.03
Sources of Funds				
Depreciation	$4.27	$ .07	$ .08	$ 4.43
Retained Earnings	2.13	.10	.13	2.37
Subtotal--Internal Sources	$6.40	$ .17	$ .22	$ 6.79
Issues of Long-Term Debt	$1.24	$ .94	$ .54	$ 2.72
Issues of Common Stock	.73	.59	1.20	2.52
Subtotal--External Financing	$1.97	$1.53	$1.74	$ 5.24
Total Sources	$8.37	$1.71	$1.96	$12.03

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-20

SOURCES AND APPLICATIONS OF FUNDS FOR PESSIMISTIC DEMAND
1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$22.34	$3.41	$2.95	$28.70
Changes in Working Capital	3.42	.19	.16	3.78
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$26.98	$3.60	$3.11	$33.70
Sources of Funds				
Depreciation	$12.86	$ .80	$ .82	$14.48
Retained Earnings	5.47	.42	.44	6.33
Subtotal--Internal Sources	$18.33	$1.22	$1.27	$20.81
Issues of Long-Term Debt	$ 4.86	$ .75	$ .59	$ 6.20
Issues of Common Stock	3.79	1.64	1.26	6.69
Subtotal--External Financing	$ 8.65	$2.38	$1.85	$12.88
Total Sources	$26.98	$3.60	$3.11	$33.70

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-21

SOURCES AND APPLICATIONS OF FUNDS FOR SLOW RECOVERY DEMAND 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 8.59	$ 1.71	$ 2.00	$ 12.30
Changes in Working Capital	.78	.02	.03	.83
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$ 9.85	$ 1.73	$ 2.04	$ 13.61
Sources of Funds				
Depreciation	$ 4.24	$ .07	$ .08	$ 4.39
Retained Earnings	2.13	.11	.14	2.38
Subtotal--Internal Sources	6.37	.18	.22	6.77
Issues of Long-Term Debt	2.17	.42	.51	3.10
Issues of Common Stock	1.31	1.12	1.31	3.74
Subtotal--External Financing	$ 3.47	$ 1.55	$ 1.82	$ 6.84
Total Sources	$ 9.85	$ 1.73	$ 2.04	$ 13.61

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-22

SOURCES AND APPLICATIONS OF FUNDS FOR SLOW RECOVERY DEMAND
1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 28.71	$ 3.57	$ 3.25	$ 35.52
Changes in Working Capital	4.16	.21	.18	4.55
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$ 34.08	$ 3.77	$ 3.43	$ 41.28
Sources of Funds				
Depreciation	$ 13.63	$ .82	$ .88	$ 15.32
Retained Earnings	6.11	.46	.48	7.04
Subtotal--Internal Sources	$ 19.73	$ 1.28	$ 1.36	$ 22.37
Issues of Long-Term Debt	$ 6.51	$ .75	$ .66	$ 7.92
Issues of Common Stock	7.84	1.74	1.42	11.00
Subtotal--External Financing	$ 14.35	$ 2.49	$ 2.07	$ 18.92
Total Sources	$ 34.08	$ 3.77	$ 3.43	$ 41.28

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-23

SOURCES AND APPLICATIONS OF FUNDS FOR OPTIMISTIC DEMAND WITH BASELINE CAPACITY EXPANSION 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 8.72	$1.76	$2.10	$12.58
Changes in Working Capital	1.15	.02	.04	1.21
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$10.34	$1.78	$2.14	$14.26
Sources of Funds				
Depreciation	$ 4.31	$ .07	$ .09	$ 4.47
Retained Earnings	2.25	.12	.15	2.52
Subtotal--Internal Sources	$ 6.56	$ .19	$ .23	$ 6.99
Issues of Long-Term Debt	$ 2.29	$ .43	$ .54	$ 3.26
Issues of Common Stock	1.49	1.15	1.37	4.01
Subtotal--External Financing	$ 3.78	$1.59	$1.91	$ 7.27
Total Sources	$10.34	$1.78	$2.14	$14.26

---

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-24

SOURCES AND APPLICATIONS OF FUNDS FOR OPTIMISTIC DEMAND WITH BASELINE CAPACITY EXPANSION
1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$27.50	$3.57	$3.28	$34.35
Changes in Working Capital	4.89	.22	.19	5.31
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$33.61	$3.79	$3.47	$40.87
Sources of Funds				
Depreciation	$13.76	$ .83	$ .90	$15.49
Retained Earnings	6.25	.47	.49	7.20
Subtotal--Internal Sources	$20.01	$1.30	$1.39	$22.69
Issues of Long-Term Debt	$ 6.37	$ .76	$ .67	$ 7.79
Issues of Common Stock	7.24	1.74	1.41	10.39
Subtotal--External Financing	$13.61	$2.50	$2.08	$18.18
Total Sources	$33.61	$3.79	$3.47	$40.87

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-25

SOURCES AND APPLICATIONS OF FUNDS FOR PESSIMISTIC DEMAND WITH BASELINE CAPACITY EXPANSION 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 8.72	$1.76	$2.07	$12.55
Changes in Working Capital	1.15	.02	.04	1.21
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$10.34	$1.78	$2.12	$14.23
Sources of Funds				
Depreciation	$ 4.31	$ .07	$ .09	$ 4.47
Retained Earnings	2.25	.12	.14	2.51
Subtotal--Internal Sources	$ 6.56	$ .19	$ .23	$ 6.98
Issues of Long-Term Debt	$ 2.29	$ .43	$ .53	$ 3.25
Issues of Common Stock	1.49	1.15	1.36	4.00
Subtotal--External Financing	$ 3.78	$1.59	$1.89	$ 7.25
Total Sources	$10.34	$1.78	$2.12	$14.23

---

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-26

SOURCES AND APPLICATIONS OF FUNDS FOR PESSIMISTIC DEMAND WITH BASELINE CAPACITY EXPANSION 1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$27.50	$3.57	$3.22	$34.30
Changes in Working Capital	3.52	.20	.18	3.90
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$32.24	$3.77	$3.41	$39.41
Sources of Funds				
Depreciation	$13.76	$ .83	$ .89	$15.48
Retained Earnings	6.10	.47	.48	7.04
Subtotal--Internal Sources	$19.86	$1.29	$1.37	$22.52
Issues of Long-Term Debt	$ 6.02	$ .75	$ .65	$ 7.42
Issues of Common Stock	6.36	1.73	1.38	9.47
Subtotal--External Financing	$12.38	$2.48	$2.04	$16.89
Total Sources	$32.24	$3.77	$3.41	$39.41

---

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-27

SOURCES AND APPLICATIONS OF FUNDS FOR ALL MANUFACTURING RETURN ON EQUITY
1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 8.72	$ 1.76	$ 2.09	$ 12.56
Changes in Working Capital	1.09	.02	.06	1.17
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$10.28	$ 1.78	$ 2.14	$ 14.20
Sources of Funds				
Depreciation	$ 4.31	$ .07	$ .09	$ 4.47
Retained Earnings	2.96	.14	.17	3.27
Subtotal--Internal Sources	$ 7.27	$ .21	$ .26	$ 7.74
Issues of Long-Term Debt	$ 2.27	$ .44	$ .54	$ 3.26
Issues of Common Stock	.73	1.13	1.35	3.21
Subtotal--External Financing	$ 3.00	$ 1.58	$ 1.89	$ 6.46
Total Sources	$10.28	$ 1.78	$ 2.14	$ 14.20

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-28

SOURCES AND APPLICATIONS OF FUNDS FOR ALL MANUFACTURING RETURN ON EQUITY 1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 27.50	$ 3.57	$3.25	$34.33
Changes in Working Capital	4.24	.23	.21	4.68
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$ 32.96	$ 3.80	$3.46	$40.22
Sources of Funds				
Depreciation	$ 13.76	$ .83	$ .90	$15.49
Retained Earnings	8.56	.63	.65	9.84
Subtotal--Internal Sources	$ 22.32	$ 1.46	$1.55	$25.33
Issues of Long-Term Debt	$ 6.20	$ .77	$ .67	$ 7.64
Issues of Common Stock	4.44	1.58	1.24	7.26
Subtotal--External Financing	$ 10.64	$ 2.35	$1.91	$14.90
Total Sources	$ 32.96	$ 3.80	$3.46	$40.22

---

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-29

SOURCES AND APPLICATIONS OF FUNDS FOR STEEL OPERATIONS RETURN ON EQUITY 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 8.72	$1.76	$2.09	$12.56
Changes in Working Capital	.98	.03	.04	1.05
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$10.17	$1.79	$2.13	$14.09
Sources of Funds				
Depreciation	$ 4.31	$ .07	$ .09	$ 4.47
Retained Earnings	1.31	.07	.09	1.47
Subtotal--Internal Sources	$ 5.63	$ .14	$ .17	$ 5.94
Issues of Long-Term Debt	$ 2.25	$ .45	$ .52	$ 3.22
Issues of Common Stock	2.30	1.20	1.44	4.93
Subtotal--External Financing	$ 4.54	$1.65	$1.96	$ 8.15
Total Sources	$10.17	$1.79	$2.13	$14.09

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-30

SOURCES AND APPLICATIONS OF FUNDS FOR STEEL OPERATIONS RETURN ON EQUITY 1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$27.50	$3.57	$3.25	$34.33
Changes in Working Capital	3.93	.20	.18	4.31
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$32.65	$3.77	$3.43	$39.85
Sources of Funds				
Depreciation	$13.76	$ .83	$ .90	$15.49
Retained Earnings	3.13	.23	.25	3.61
Subtotal--Internal Sources	$16.90	$1.05	$1.14	$19.09
Issues of Long-Term Debt	$ 6.13	$ .76	$ .64	$ 7.53
Issues of Common Stock	9.63	1.95	1.64	13.22
Subtotal--External Financing	$15.76	$2.72	$2.28	$20.75
Total Sources	$32.65	$3.77	$3.43	$39.85

[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-31

SOURCES AND APPLICATIONS OF FUNDS FOR HIGHER COST OF CAPITAL
1975-1977

(billions of 1975 dollars)

	Production and Full Pollution Control: Baseline Cost of Capital	Production and Full Pollution Control: + 1% Cost of Capital	Differential
Applications of Funds			
Capital Expenditures	$12.57	$12.57	$ 0
Changes in Working Capital	1.21	1.21	0
Refundings of Long-Term Debt	.47	.47	0
Total Applications	$14.25	$14.25	$ 0
Sources of Funds			
Depreciation	$ 4.47	$ 4.47	$ 0
Retained Earnings	2.51	2.73	.22
Subtotal--Internal Sources	$ 6.98	$ 7.20	$.22
Issues of Long-Term Debt	$ 3.25	$ 3.25	$(*)
Issues of Common Stock	4.01	3.79	(.22)
Subtotal--External Financing	$ 7.26	$ 7.04	$(.22)
Total Sources	$14.25	$14.25	$ 0

*slightly less than $.005 billion

Source: PTm(Steel)

Exhibit E-32

SOURCES AND APPLICATIONS OF FUNDS FOR HIGHER COST OF CAPITAL
1975-1983

(billions of 1975 dollars)

	Production and Full Pollution Control: Baseline Cost of Capital	Production and Full Pollution Control: + 1% Cost of Capital	Differential
Applications of Funds			
Capital Expenditures	$34.42	$34.32	$ 0
Changes in Working Capital	4.61	4.61	0
Refundings of Long-Term Debt	1.22	1.22	0
Total Applications	$40.15	$40.15	$ 0
Sources of Funds			
Depreciation	$15.49	$15.49	0
Retained Earnings	7.13	7.90	.77
Subtotal--Internal Sources	$22.61	$23.39	$ .77
Issues of Long-Term Debt	$ 7.60	$ 7.60	(*)
Issues of Common Stock	9.92	9.16	(.76)
Subtotal--External Financing	$17.54	$16.76	$(.77)
Total Sources	$40.15	$40.15	0

*slightly less than $.005 billion

Source: PTm(Steel)

Exhibit E-33

SOURCES AND APPLICATIONS OF FUNDS FOR BPCTCA COMPLIANCE IN 1977
1975-1977

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$1.56	$.13	$.11	$ 1.80
Changes in Working Capital	.06	0	0	.06
Total Applications	1.62	.13	.11	1.86
Sources of Funds				
Depreciation	$ .14	$0	$0	$ .14
Retained Earnings	.18	.01	.01	.19
Subtotal--Internal Sources	.32	.01	.01	.33
Issues of Long-Term Debt	$ .38	$.03	$.03	$ .44
Issues of Common Stock	.93	.09	.08	1.09
Subtotal--External Financing	$1.30	$.12	$.11	$1.52
Total Sources	$1.62	$.13	$.11	$1.86

Source: PTm(Steel)

Exhibit E-34

SOURCES AND APPLICATIONS OF FUNDS FOR BPCTCA COMPLIANCE IN 1977
1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$1.56	$.87	$.41	$2.84
Changes in Working Capital	.08	.05	.02	.14
Total Applications	$1.64	$.92	$.43	$2.99
Sources of Funds				
Depreciation	$ .59	$.13	$.06	$ .78
Retained Earnings	.32	.08	.04	.45
Subtotal--Internal Sources	$ .91	$.21	$.10	$1.22
Issues of Long-Term Debt	$ .27	$.20	$.09	$ .56
Issues of Common Stock	.46	.51	.23	1.20
Subtotal--External Financing	$ .73	$.71	$.33	$1.76
Total Sources	$1.64	$.92	$.42	$2.98

Source: PTm(Steel)

Exhibit E-35

SOURCES AND APPLICATIONS OF FUNDS FOR BPCTCA COMPLIANCE IN 1981
1975-1977

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$1.04	$.13	$.11	$1.28
Changes in Working Capital	.02	0	0	.02
Total Applications	$1.06	$.13	$.11	$1.30
Sources of Funds				
Depreciation	$ .05	$0	$0	$ .05
Retained Earnings	.08	.01	.01	.09
Subtotal--Internal Sources	$ .12	$.01	$.01	$ .14
Issues of Long-Term Debt	$ .26	$.03	$.03	$ .32
Issues of Common Stock	.68	.09	.08	.84
Subtotal--External Financing	$ .93	$.12	$.11	$1.16
Total Sources	$1.06	$.13	$.12	$1.29

Source: PTm(Steel)

Exhibit E-36

SOURCES AND APPLICATIONS OF FUNDS FOR BPCTCA COMPLIANCE IN 1981
1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Applications of Funds				
Capital Expenditures	$1.54	$.87	$.41	$2.82
Changes in Working Capital	.08	.05	.02	.14
Total Applications	$1.61	$.92	$.43	$2.96
Sources of Funds				
Depreciation	$ .46	$.13	$.06	$ .64
Retained Earnings	.24	.08	.04	.36
Subtotal--Internal Sources	$ .70	$.21	$.10	$1.01
Issues of Long-Term Debt	$ .29	$.20	$.09	$ .59
Issues of Common Stock	.62	.51	.23	1.36
Subtotal--External Financing	$ .92	$.71	$.33	$1.95
Total Sources	$1.61	$.92	$.42	$2.96

Source: PTm(Steel)

Exhibit E-37

SOURCES AND APPLICATIONS OF FUNDS FOR ZERO COST PASS-THROUGH 1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$ 8.72	$1.76	$2.09	$12.56
Changes in Working Capital	1.15	.02	.04	1.21
Refundings of Long-Term Debt	.47	-	-	.47
Total Applications	$10.34	$1.78	$2.13	$14.24
Sources of Funds				
Depreciation	$ 4.31	$ .07	$ .09	$ 4.47
Retained Earnings	1.77	(.06)	(.06)	1.65
Subtotal--Internal Sources	$ 6.09	$ .02	$ .02	$ 6.12
Issues of Long-Term Debt	$ 2.29	$ .43	$ .53	$ 3.26
Issues of Common Stock	1.96	1.33	1.58	4.87
Subtotal--External Financing	$ 4.25	$1.76	$2.11	$ 8.12
Total Sources	$10.34	$1.78	$2.13	$14.24

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[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

Exhibit E-38

SOURCES AND APPLICATIONS OF FUNDS FOR ZERO COST PASS-THROUGH 1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Applications of Funds				
Capital Expenditures	$27.50	$3.57	$3.25	$34.33
Changes in Working Capital	4.21	.21	.19	4.61
Refundings of Long-Term Debt	1.22	-	-	1.22
Total Applications	$32.93	$3.78	$3.44	$40.15
Sources of Funds				
Depreciation	$13.76	$ .83	$ .90	$15.49
Retained Earnings	4.89	(1.18)	(1.15)	2.56
Subtotal--Internal Sources	$18.66	$(.35)	$(.25)	$18.05
Issues of Long-Term Debt	$ 6.19	$ .75	$ .66	$ 7.61
Issues of Common Stock	8.08	3.38	3.03	14.49
Subtotal--External Financing	$14.27	$4.13	$3.69	$22.10
Total Sources	$32.93	$3.78	$3.44	$40.15

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[1] Includes pollution control equipment placed into service prior to 1975.

Source: PTm(Steel)

APPENDIX F

CAPITAL AVAILABILITY

APPENDIX F

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APPENDIX F

LIST OF EXHIBITS

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CAPITAL AVAILABILITY

Section 7 and Appendix E of this report have presented the external financing requirements of the steel industry for baseline capacity expansion and maintenance and for compliance with air and water pollution control regulations. Section 7 of the report also commented on the projected availability of capital to meet these external financing needs. This appendix presents additional detail concerning the availability of capital over the 1975 to 1983 period.

The steel industry's ease of access to external financing is in part determined by the industry's own financial strength and in part by overall capital market conditions. Both of these areas are reviewed in this appendix through the use of historical reviews and future projections.[1] The first part of this appendix presents a discussion of recent trends and cycles in total corporate financing. The second part reviews the steel industry's recent financing history. The third part of the appendix discusses possible future trends in total corporate financing, in the funds required to finance governmental and housing expenditures, and in household savings. Finally, the last part examines the steel industry's projected financing needs in the context of total capital market conditions.

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[1] *TBS was assisted by Professor Jay Light of the Harvard Business School in the capital markets analysis of this appendix and has drawn heavily on data developed by him for a forthcoming book, Capital Markets.*

RECENT TRENDS AND CYCLES IN CORPORATE BUSINESS FINANCING

Steel industry financing in recent years has taken place as part of a rapid increase in financing needs throughout the corporate sector. In the late 1960s and early 1970s, corporate demands for external funds became the largest and fastest growing element of financial needs throughout the economy. Indeed, in the credit crunches of 1966, 1969-1970, and 1973-1974, these needs became so large that they created strains throughout financial markets and "crowded out" other potential borrowers. By 1975, an increasing recognition of the importance of these growing and cyclical corporate financial needs was reflected in a number of projections of future financial markets. Despite very modest external corporate needs in 1975, a number of financial forecasters remained concerned about the possibility of a future "capital shortage" caused in part by the external financing needs of corporations.

In order to gain insight into future total corporate external financing needs and capital market conditions, and thus into future conditions affecting the steel industry, this chapter contains an analytical review of recent trends in total non-financial corporate financing. In addition, in order to show their importance within the overall financial system, these corporate financial needs will be compared with the financing of other economic sectors.

THE NEED FOR CORPORATE FINANCING

In order to evaluate the underlying demand for funds in the corporate sector, TBS has focused on the non-financial corporate business sector as defined in Flow of Funds Accounts, published by the Federal Reserve Board (FRB). (This sector includes only domestic non-financial business corporations, and excludes financial corporations, whose demands for funds are derived from the financing needs of others and whose inclusion would therefore "double-count" some financing.) Exhibit F-1, derived from the FRB Flow of Funds data, displays the total uses of funds, and therefore the total funds needs, of non-financial business corporations over the previous 15 years. These total financing needs have grown from $44 billion in 1960 to $163 billion in 1974.

Total corporate financing needs consist of two major components:

- The need for additional real assets (plant and equipment, residential construction, and inventory); and
- The need for increased financial assets (liquid assets, accounts receivable, etc.)

In addition, about 10 percent of the total uses of funds cannot be categorized due to data deficiencies, and these are included in the item "discrepancy." As shown by Exhibit F-1, new plant and equipment generally accounted for from 65 to 80 percent of non-financial business corporations' total financing needs in the last 15 years and is consequently the dominant component of these needs.

Interpretations of the raw data of Exhibit F-1 are complicated by two factors. First, while the number of uses of funds has been increasing rapidly, this growth could simply be due to the overall economic growth and inflation of recent years. Second, there are apparent cyclical swings in these and other financial data which may obscure and confuse the underlying secular trends.

In order to clarify the information as far as possible, the last two decades have been divided into five non-overlapping credit cycles which correspond generally to the economic cycles of recent years: the final two cycles of the 1950s, the credit cycle of the early 1960s which culminated in the credit crunch of 1966, the credit cycle (some would say "mini-cycle") of the late 1960s, and the credit cycle of 1970-1974 which culminated in the credit crunch of 1973-1974[2]. Within each of these credit cycles, the various corporate uses of funds will be shown as a percent of gross national product (GNP) to normalize them in respect to the prevailing size of the economic and financial system. Most of the data which follow will be displayed in the same manner, to provide some insights into secular changes within the last two decades.

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[2] *More precisely, the cycles are each composed of a series of consecutive calendar quarters as follows: 1954:3 through 1958:1; 1958:2 through 1960:4; 1961:1 through 1967:1; 1967:2 through 1970:3; and 1970:4 through 1974:4.*

Utilizing these definitions of credit cycles, Exhibit F-2 documents the secular trends in corporate financing needs in connection with GNP over the last two decades. "Total Financing Needs," the total of all the separate uses of funds, increases in a relatively steady pattern over these cycles. The most important source of this increase is plant and equipment investment, but inventories and net financial assets also contribute to the secular trend.

CORPORATE SOURCES OF FUNDS

The total financing needs of corporations must be met from one of two principal sources: externally raised funds and internally generated funds, composed of adjusting retained earnings[3] and depreciation. Exhibit F-3 shows how the total financing needs of corporations have been funded over the last 15 years. Although internally generated funds gradually have grown from $34.4 billion in 1960 to $81.5 billion in 1974, as a percentage of total financing needs, they declined from 78 percent in 1960 to only 50 percent in 1974. Exhibit F-4 shows these same sources of funds as a percentage of GNP over the five credit cycles defined above.

Exhibits F-3 and F-4 document what has probably been the most important recent trend in financial markets: the increasing need for external funds to fill the "gap" between total financing needs and internally generated

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[3] *Adjusted retained earnings (or adjusted retained profits) are retained earnings adjusted for inventory valuation profits which provide no cash flow. See the definitions accompanying Exhibit F-3 for further explanation.*

funds. More precisely, from the first to the third credit cycle, industry's total financing needs grew substantially, but they were accompanied by an almost equal expansion of internally generated funds, which made the external funds raised in financial markets relatively stable. Conversely, from credit cycle 3 to credit cycle 5 total financing needs continued to increase, but internally generated funds shrank as a percent of GNP. This resulted in the external funds raised by non-financial corporations expanding rapidly from 2.7 percent to 5.1 percent, almost doubling as a percent of GNP. And, of course, the external funds measured in absolute dollars expanded even more rapidly, as is shown in Exhibit F-3.

In addition to external funds raised, it is useful to have a measure of the net extent to which corporations have demanded funds from the financial system. While the external funds raised in financial markets withdrew funds from the financial system, the increase in liquid financial assets on corporate balance sheets has served as an offsetting supply of funds. In Exhibit F-4 this net measure of corporate financial demands, "net external funds required," is computed for each past credit cycle. As shown in Exhibit F-4, net external funds have also expanded rapidly, from an average of 2.4 percent of GNP in credit cycle 1 to 4.3 percent of GNP in credit cycle 5.

In brief, these external needs have been the cause of recent concern about the ability of the U.S. financial markets to accommodate needed corporate financing. Through the last several cycles of expanding investment needs, the internally-generated funds of corporations have declined, opening up a severe cash flow "gap" which could only be filled by external funds. Or, to interpret the facts somewhat differently, in a time when corporations have found it increasingly difficult to generate internal funds, they have nonetheless maintained and even expanded their rate of investment and then have funded this investment through external financing, primarily borrowing.

INFLATION AND THE NEED FOR EXTERNAL FUNDS

One of the most important factors leading to the external funds requirements of recent cycles has been the accelerating pace of inflation. Inflation affects the operational financial needs of corporations in several ways. Inflation (1) raises the current or nominal cost of any new plant and equipment, inventory, or financial asset expansion needed to support real growth; (2) raises the cost of replacing the inventories and the plant and equipment that are consumed in the production process; and (3) increases the dollar amount of financial assets required to maintain a given volume of real business activity. Consequently, inflation leads to an expanded need for funds. Inflation has caused much of the increase in the ratio of total financial needs to GNP shown in Exhibit F-2.

Inflation also affects the capacity of firms to generate funds internally since depreciation is based upon historical costs. Inflation leads to higher wage rates, higher unit labor costs, and increased production costs. Expectations of inflation affect interest rates and the level of interest payments.

The corporate income tax system is another major force through which inflation affects businesses' internal funds. When computing income for tax purposes, corporations are allowed to charge depreciation only on the basis of historical cost. As a result, taxable income is overstated in connection with the cash flows that can be invested in net new assets by the difference between depreciation based on historical costs and depreciation based on replacement costs. Similarly, the interaction of the corporate tax system and inflation can also produce an unnecessary cash outflow in the form of higher taxes when inflationary price increases lead business firms to replace inventories at higher price levels. Essentially, firms have paid taxes upon inventory profits which were not available for net new investment.

As illustrated in Exhibits F-3 and F-4, total financing needs increased during the inflationary period of 1971-1974. However, even though business prices rose substantially, internal funds did not grow commensurately. The inflation resulted in wage and salary payments taking a larger share of the total revenues generated by corporations. An increased outflow of tax payments in connection with the replacement cost of plant and equipment inventories reduced internal funds as well.

During inflationary periods there have often been enormous political pressures to hold down prices. These pressures can take the form of "jaw-boning" from public officials, or, as in recent periods, direct controls. Furthermore, in recent years, corporations have found it difficult to raise prices because of reduced consumer demand. For these reasons, corporations recently have been unable to maintain their internally generated funds in inflationary periods, and increasingly have turned to external sources of funds.

EXTERNAL FUNDS RAISED IN FINANCIAL MARKETS

External funds can be raised in financial markets in the form of increased short-term debt, increased long-term debt, or new equity issues. The principal source of short-term debt for corporations has been the commercial banking system. To some extent, large corporations with prime credit ratings can supplement this use of bank debt with their own short-term promissory notes, called commercial paper. Some corporations use other sources of short-term debt such as finance company loans. A special component of short-term debt, usually called the profit tax liability, arises through the normal process of paying taxes.[4] Taken together, however, the profit tax liability, commercial paper, finance company loans, and other miscellaneous loans form only a small portion of corporate debt. Recently, bank debt has dominated the total sources of short-term funds.

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[4] *Since profit taxes are not paid in cash exactly as they are accrued, corporations have a short-term liability to the government--profit taxes payable--at the end of any quarter or year. In times when profits and taxes are rising, the size of this liability also rises, providing a form of short-term financing to corporations. In the 1950s, when there was a significant lag in the processing of tax collections, this short-term liability sometimes was a significant portion of total short-term finance. Recently, however, as the schedule of tax collections has accelerated, the profit tax liability has become relatively unimportant.*

In addition, commercial banks have often made term loans to corporate business. Over one-third of all bank loans in recent years have been term loans. These term loans generally are considered to be intermediate-term finance, longer than one year (the arbitrary breakpoint for most definitions of short-term debt) yet shorter than the typical 15- to 30-year maturities of "long-term debt." However, because of definition problems and corresponding deficiencies in the data, all bank loans are included in the "short-term debt" category in the analysis in this volume.

THE CYCLICAL PATTERNS OF EXTERNAL FUNDS

This discussion has concentrated thus far on the secular trends in external financial needs within the corporate sector, by averaging the observed flows-of-funds across credit cycles. Within each cycle, however, there are marked variations in financing activity caused by the cycles in inventory accumulation and, to a lesser extent, by plant and equipment spending. Toward the middle or end of each credit cycle, corporate external funds requirements have reached their cyclical peak.

Exhibit F-5 displays the changing patterns of corporate external funds. In addition to the cyclical nature in the total of these new funds, there appears to be a cyclical pattern in their composition. In the early phases of each credit cycle, long-term sources of funds (particularly long-term debt) are the principal sources of new funds. Towards the middle of each credit cycle, as total new funds are usually accelerating rapidly, a shift occurs away from a primary reliance upon long-term debt and toward short-term debt. Toward the end of each credit cycle, in the economic recession or slow-down, long-term debt resumes its role as the principal source of external funds.

This typical pattern is evident in the data for the most recent credit cycle. In 1971 and early 1972, long-term capital, particularly long-term debt and net new equity issues, provided over $41 billion, or about 85 percent of the new external funds of corporations. In the face of rising needs in 1973, however, these sources both decreased. By early 1974, historically large quantities of short-term debt, over $45.3 billion, had become the mainstay of corporate external financing. Most of this financing was provided through the commercial banking system, and the size of banks grew rapidly in this period to accommodate these short-term needs; however, by the final quarter of 1974 and throughout 1975, this short-term debt decreased sharply and was replaced once again by the rapidly growing contribution of long-term funds.

THE CHANGING CORPORATE BALANCE SHEET

Recently, there have been several important secular trends in corporate balance sheet ratios: increasing levels of debt in connection with equity, a changing ratio of short-term debt to long-term debt, and decreasing relative levels of liquid asset balances. (Exhibit F-6 illustrates the changing levels of debt and liquid assets as a percent of GNP.) These trends have contributed to a more debt-heavy, and perhaps more fragile, corporate financial structure.

The limits to these financial trends are not obvious. On the one hand, corporations in some other countries have continually operated with debt ratios that are high by U.S. standards. A comparison with other countries would suggest the U.S. corporations should have relatively little to fear from their new financial structures. On the other hand, some observers recently have suggested that the corporate sector should not, and indeed will not, increase its debt financing beyond the levels reached in the mid-1970s.

CORPORATE EXTERNAL FUNDS WITHIN THE FINANCIAL SYSTEM

Business corporations are only one of the seekers of funds in the financial markets. The other important demands come from households (for both home mortgages and consumer credit) and from governments. The recent patterns of these other credit demands as compared to corporate demands are shown in Exhibit F-7. The dominant conclusion that emerges from these data is that both corporate external financing and the borrowing of other sectors rose during this period. The combination of inflation, fiscal and monetary policies of government, and financing and saving decisions of various private sectors gave rise to a total expansion of financial assets and liabilities (credit). The frequently described rise in corporate external funds was the dominant factor in this expansion, increasing from $10 billion in 1960 to $81.5 billion in 1974. It was accompanied by smaller increases from other sectors. As a result, corporate business liabilities grew from 34 percent of the total in 1960 to 54 percent of the total in 1974.

The total financing of all sectors is limited by the rate of growth of total credit, which is determined partly by the financial decisions of savers and partly by the decisions of the Federal Reserve Board. The various credit seekers must compete for a limited supply of financing. Business corporations appear to be relatively effective competitors for funds because of their insensitivity to interest costs. Households appear to be the economic sector most likely to be "crowded out" during a credit crunch because of their relative sensitivity to interest costs. This process is illustrated in Exhibit F-8, which records corporate debt financing as a percent of all private sector debt financing. Corporations have been taking a secularly increasing percentage of the total financing available to the private sector. In a credit crunch, when the Federal Reserve restricted the overall growth of credit but corporate external needs were still large, these percentages were particularly high.

In 1966-1967, 1970, and 1973-1974, the corporate sector obtained about 60 percent of the available financing ($62 billion in 1973 and $77.5 billion in 1974) and the borrowing of households was curtailed severely. Faced with the high interest costs of these periods, households decided to reduce their rate of borrowing. This "crowding out" of households has had important implications for economic activity. It probably was the primary cause of the great cycles in new home construction in these periods. While there is some disagreement as to the reasons involved in this "crowding out" of home mortgage and other household borrowings, there is agreement that it has in fact occurred during each of our recent credit crunches. It is generally believed that the potential borrowing of small businesses, larger financially weak businesses, and state and local governments is also influenced by interest costs, and is likely to be curtailed during times of tight credit. If the external financial needs of corporations, particularly large credit-worthy corporations, grow, the likelihood is that there will be less financing available for the more interest-sensitive borrowers: households, small businesses, state and local government, and large but financially weak corporations.

CORPORATE FINANCING IN 1975

The severe recession of 1975 resulted in some major changes in the pattern of corporate financing. Plant and equipment spending eased somewhat and there was a massive inventory liquidation. These events combined to reduce the total financial needs of corporations, while internally generated funds fell only slightly. The result was a substantial reduction in the external funds required raised by non-financial corporations in the first half of 1975, declining in that period to about 1.8 percent of GNP. Compared with the recent levels of 5 and 6 percent of GNP shown in Exhibit F-5, this is a dramatic reduction. Furthermore, liquid asset balances were increased and short-term debt was drastically reduced by the massive new issues of long-term debt in 1975. These changes are not particularly surprising, however, given the recession and especially the rate of inventory liquidation accompanying the recession of the last two years.

RECENT TRENDS IN STEEL INDUSTRY FINANCING, 1960-1975

This section of Appendix F will examine the sources and uses of funds for the domestic steel industry for the past 15 years and will discuss the changes in industry capital structure which have taken place during this period. The section will also comment on the recent valuation of steel industry equity by the capital markets. The financial data used here have been drawn in large part from the Annual Statistical Reports of the American Iron and Steel Institite. These data include steel companies which represent approximately 93 percent of domestic raw steel production. In addition, these data include non-steel as well as steel operations. Information received by TBS from AISI indicates that, for the top five companies in the industry, steel operations revenues account for approximately 79 percent of total revenues on average, and fixed assets for steel operations are approximately 57 percent of total fixed assets. However, since the structure of these firms is not typical of the industry, no attempt has been made to adjust the total industry financial data for non-steel operations.

STEEL INDUSTRY USES OF FUNDS, 1960-1974

Exhibit F-9 details the uses of funds for the steel industry in the 1960 to 1974 period and compares the total of these uses to the total for all domestic, non-financial corporations. Uses of funds includes capital expenditures, changes in working capital and miscellaneous and other uses of funds. The table below summarizes Exhibit F-9 through presentation of average figures for the three 5-year periods which span the period.

AVERAGE ANNUAL FUNDS USED BY THE STEEL INDUSTRY
(billions of dollars)

	Capital Expenditures	Changes in Working Capital	Total Requirements	Total as Percent of Non-Financial Corporations
1960-1964	1.20	.06	1.27	2.34%
1965-1969	2.06	(.16)	1.89	2.14%
1970-1974	1.57	.46	1.98	1.50%

The major use of funds in all years was capital expenditures, which ranged from $.9 to $2.3 billion per year. The pattern of expenditures shows considerable variability with relatively high expenditures during a period of modernization from 1965 through 1969 and again in 1974. This results in the average annual capital expenditures for the 1965-1969 period increasing from $1.2 billion in the previous five-year period to $2.1 billion, a rise of 72 percent. Expenditures then decrease on average in the final five-year period to $1.6 billion, a reduction of 24 percent, but still 31 percent above the first five-year period.

Change in working capital is the other significant use of funds for the steel industry. This line item reflects the industry's need for increased or decreased financial assets and inventories. As shown in Exhibit F-9, changes in working capital were more volatile than capital expenditures over the period and during the years from 1966 through 1969 and again in 1971 the level of working capital actually decreased, thus yielding a net source of funds. Most of the reduction in working capital in these years appears to have been in cash and other liquid assets. In recent years, increases in working capital have occurred at a relatively rapid rate, primarily due to increased accounts receivable during years of high sales volume.

Decreases in working capital represent a liquidation of cash, securities, and other current assets to be used as a source of funds during the years of relatively high capital expenditures. These two factors have offset each other and as a result, the total funds used by the steel industry during the 1960 to 1974 period is less volatile than either of its major components. Total steel industry uses of funds ranged from $.9 to $3.1 billion per year. However, if 1974 is excluded, the range of total funds use is $.9 to $2.2 billion per year, with an average of $1.6 billion per year. The average annual funds required increased during each consecutive five-year period with the largest increase, approximately 49 percent, occurring between the first and second periods. The increase in the average between the second and third periods was a relatively small 5 percent.

The bottom lines of Exhibit F-9 present the total funds used by domestic non-financial corporations and the percentage of this total accounted for by the steel industry. The steel industry's share of the total has ranged from a high of 2.8 percent in 1961 to a low of 1.2 percent in 1973. The industry's average share has fallen steadily from 2.3 percent for the 1960-1964 period to 1.5 percent for the 1970-1974 period. It is clear from these figures that the steel industry's percentage of the total funds used in the economy has decreased over time.

STEEL INDUSTRY SOURCES OF FUNDS, 1960-1974

The steel industry has not needed to play a major role in the financial markets during the 1960 to 1974 period. Exhibit F-10 displays the sources of the industry's funds during this period and compares these to the totals for the economic system as a whole. As this exhibit illustrates, internal sources represents the major source of funds during the period.

Internal sources of funds for the steel industry are made up of retained earnings, depreciation, and changes in reserves. The table below displays the two major internal sources and the total as average annual flows for each of the three 5-year periods. Steel industry internal sources as a percent of the total for non-financial corporations are also included.

AVERAGE ANNUAL INTERNAL SOURCES FOR THE STEEL INDUSTRY
(billions of dollars)

	Retained Earnings	Depreciation	Total Internal	Percent of Total for Domestic, Non-Financial Corporations
1960-1964	.26	.89	1.17	2.80%
1965-1969	.49	1.10	1.74	2.89%
1970-1974	.64	1.18	1.92	2.72%

Depreciation provided the largest internal funds flow in all years and on average increased slightly. Depreciation flows varied from $.70 to $1.34 billion per year with an overall average of $1.05 billion per year.

Retained earnings provided the other major portion of internal sources. This figure was more variable over the period and did not increase substantially until 1974. Exhibit F-11 presents the net income, dividends paid, retained earnings, and the resulting dividend payout ratio for each of the years. As this exhibit illustrates, the actual amount of dividends paid ranged from $.4 to $.7 billion per year while net income varied from $.5 to $2.5 billion per year. The relatively stable amount of dividends paid each year, when subtracted from the highly variable net income, produced wide swings in retained earnings and in the dividend payout ratio. These data imply that industry management felt it more important to maintain a relatively constant stream of nominal payments to stockholders rather than reflect the current earnings situation in dividend payments. The latter course of action would have resulted in more level flows from retained earnings.

Changes in reserves provided a third and relatively minor contribution to internal sources. This flow ranged from $.01 to $.35 billion per year with an average figure of $.09 billion per year. Changes in reserves exhibited no particular pattern over the period.

The total steel industry internal sources were relatively stable from 1960 to 1974, due primarily to the large depreciation flows. This funds flow, which ranged from $.9 billion to $3.4 billion, was in large part sufficient to provide for the industry's funds requirements over the period. Steel industry internal sources also maintained on average their percentage share of the internal sources for all domestic, nonfinancial corporations.

The adequacy of internal sources relative to the steel industry's uses of funds over the 1960 to 1974 period allowed the industry to play only a minor role in the capital markets. As Exhibit F-10 illustrates, total external sources of funds were small during this period. In all but the four years of the period, the industry increased its long-term debt by small amounts. In 1973 and 1974 the industry became a net refunder of debt and the total long-term debt outstanding was decreased by $.6 billion. The situation was similar concerning equity. The industry was a net issuer of very little equity over the 1960 to 1974 period and in six specific years, total stockholders' equity actually decreased, largely due to reductions in preferred stock outstanding. The table below displays the average external financing flows for the three 5-year periods from 1960 to 1974. (Preferred and common stock are included in stockholder equity.)

AVERAGE EXTERNAL FINANCING ISSUED BY THE STEEL INDUSTRY
(billions of dollars)

	Issues of Long-Term Debt	Issues of Stockholder Equity	Total External Funds	Percent of Total for Domestic, Non-Financial Corporations
1960-1964	.10	.01	.11	2.11%[a]
1965-1969	.35	(.20)	.15	.80%[b]
1970-1974	.01	.05	.06	.75%[a]

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[a] *three-year average*

[b] *four-year average*

Long-term debt increased during each five-year period, although only slightly in the years between 1970 and 1974. Stockholders' equity was reduced during the 1965-1969 period and was increased slightly during the other two periods. Average external financing for the industry as a percent of the total for all domestic, non-financial corporations declined in each of the five-year periods, and particularly between the first and second period. This was possible despite a major capital expenditures program in the late 1960s due to the adequacy of internal sources and use of working capital reductions as a source of funds.

As a result of the trends in equity and debt financing from 1960 to 1974, relatively little external financing was issued and the industry was a net refunder of external financing in five of the fifteen years. Total net external financing, when positive, ranged from $.1 to $.6 billion with an average of $.3 billion. Net refunds of external financing ranged from $.1 to $.3 billion with an average of $.2 billion. As a percent of the total external financing required by domestic, non-financial corporations, the steel industry's needs ranged from .2 to 1.3 percent.

CHANGES IN STEEL INDUSTRY CAPITAL STRUCTURE

Despite the relatively minor external financing carried out by the steel industry over the 1960 to 1974 period, significant changes did occur in the industry's capital structure. Exhibit F-12 outlines these changes. As illustrated in this exhibit, the equity portion of total capitalization fell from 77.5 percent to 66.0 percent over the first two-thirds of the period and enjoyed a slight increase to 71.0 percent from 1970 to 1974. The major part of this change was due to changes in equity outstanding, with a smaller effect generated by retained earnings over the period.

Long-term debt as a percentage of total capitalization exhibited an opposite pattern to equity, with an increase from 18.3 percent to 26.1 percent in the first ten years of the period and a decrease to 20.3 percent in the last five years of the period. Reserves and deferred credits exhibit nearly constant growth from 4.2 percent to 8.2 percent during the period.

The overall effect of these changes is a more debt-intensive capital structure in 1974 than in 1960. The total amount of debt as a percentage of capital had decreased by 1974 from the levels of 1971 and 1972, but the industry's debt to capital ratio was still higher in 1974 than in 1960. Relative to many other industries, however, the steel industry in 1974 was still a relatively unleveraged industry.

STEEL INDUSTRY ACCESS TO THE CAPITAL MARKETS

Although the steel industry did not enter the capital markets in order to raise major financing during the 1960 to 1974 period, several observations about its apparent ability to do so are pertinent. The table below summarizes, in the form of five-year averages, several ratios which pertain to the industry's ability to raise external capital. These ratios are displayed in detail in Exhibits F-13 and F-14.

STEEL INDUSTRY FINANCIAL PARAMETERS
(five-year average)

	Interest Coverage	Price to Earnings[1] Ratio	Market to Book[1] Ratio
1960-1964	15.00	17.03	1.66
1965-1969	11.19	10.20	1.06
1970-1974	7.60	8.87	0.54

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[1] *For the top six companies in the industry*

Two major points can be drawn from this data. First, the ability of the industry to cover its interest charges on long-term debt has decreased during the 15-year period. The ratio of earnings before interest and taxes to interest charges has fallen from 19.5 in 1960 to 8.3 in 1973, with a substantial recovery in 1974 to 14.6. Should the 1974 recovery not be maintained and the coverage ratio continue to decline, lower quality ratings for the industry's debt and higher interest rates on its issues would result.

Individual companies within the steel industry have a range of capital structures, coverage ratios, and bond ratings. Debt to equity ratios (1974) for the top six firms ranged from .22 to .42, with the ratios for smaller steel firms ranging from .16 to .80. Further, as of March 1976 the top six steel producers had bond ratings of AA or A, while most other firms in the industry had BBB or BB ratings.

The second major point concerns the valuation of the industry's equity by investors. Both measures of this valuation have shown a dramatic decrease over the period. The average price/earnings ratio for the top six companies[5] in the industry is approximately half of its value during the early sixties. Further, the ratio of share price to per share book value of assets has fallen dramatically from 1.66 in the first five-year period to .54 in the period from 1970 to 1974. At recent levels it would have been impossible for the industry to issue common equity without seriously diluting the book value of shares held by current stockholders.

UPDATE: 1975

Highlights of the financial results of steel industry operations in 1975 are as follows:

- Capital expenditures for 1975 increased substantially to $3.2 billion, a 53.3 percent rise from the 1974 level
- External financing was $1.1 billion, or 29.7 percent of the total funds used. The overwhelming proportion of this financing was long-term debt. This level of external financing is the highest in 16 years.
- Revenues were reduced by 12 percent and net income by 36 percent from their 1974 levels. The nominal return on equity dropped from the 17.1 percent of 1974 to 9.8 percent.
- Due both to the reduction in earnings and to the increase in outstanding debt, the interest coverage ratio for the industry fell from 14.6 in 1974 to 8.2 in 1975.

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[5] *These include United States Steel, Bethlehem, Republic, National, Armco, and Inland.*

In sum, the year 1975 was a mixed one for the steel industry. Low levels of demand for steel products reduced the industry's capacity utilization and profits, thereby reducing internal cash flow. At the same time, however, the industry was able to begin a major expansion and modernization program and to finance this program through substantial issues of long-term debt.

SUMMARY

The steel industry has done little external financing during the past decade and one-half, relying instead on internal sources to fund a relatively minor series of capital expenditures and changes in working capital. Over this same period, however, the capital structure of the industry has become more debt-intensive, particularly through net reductions in outstanding equity and a nearly two-fold increase in short-term reserves and deferred credits. Largely due to shrinking earnings and higher interest rates on long-term debt being rolled over, the industry's interest coverage ratio has fallen to half its level at the beginning of the period. Finally, the value of the industry's equity appears to have been substantially reduced in the eyes of investors over the period. Undoubtedly, the primary reason for this decline has been the industry's inability to earn a satisfactory return on invested capital.

FUTURE PROJECTIONS OF CORPORATE FINANCIAL NEEDS

As documented in the first section of this appendix, there has been very rapid growth in the net external funds required by non-financial corporations over the last three credit cycles, that is, the last 15 years. And, these external funds requirements have at times placed considerable strain on the U.S. financial markets. Thus, an important factor in judging the ability of the steel industry to meet its future financing needs is the future external financing needs of other non-financial corporations. This chapter describes and analyzes three possible patterns of corporate investment and external financing requirements through 1985.

THE DETERMINANTS OF EXTERNAL FINANCING

In 1975, the external financing needs of corporations plummeted, but many observers still expect a future "capital shortage," caused largely by the investment plans of corporations. The major projected investment need is to expand productive capacity. In recent years, the U.S. economy experienced severe shortages of many economic goods, as installed productive capacity was insufficient to meet the demands of the economy, particularly in the basic materials industries (metals, chemicals, paper, etc.).

The cause of the shortages in the basic materials industries is complex. First, capacity additions in several of these industries were modest throughout the 1960s, particularly in comparison with several earlier periods. Second, the worldwide economic boom of 1972-1973 contributed to worldwide shortages in many basic materials. Third, the devaluation of the dollar made U.S. materials more attractive on a price basis and thus contributed to U.S. capacity problems. The high resultant operating ratios in the basic materials industries during 1973 led many observers to conclude that substantial additions to plant capacity will be required to reduce the threat (or capitalize on the opportunity) of future demand and supply imbalances and to attenuate wide price fluctuations in the basic materials industries.

In addition to the basic materials industries, energy production and conservation may entail major new investment. The investment in energy production will comprise expenditures both for oil exploration and for the development of alternative energy sources. Energy conservation will involve investments in mass transportation facilities, more efficient industrial processes and equipment, better insulation, etc.

Furthermore, pollution control expenditures will increase the plant and equipment spending in a number of key industries. These expenditures include investments to achieve compliance for existing capacity or to replace old capacity that cannot economically be brought into compliance. Moreover, the effective per unit cost of new plant and equipment additions will be increased by those requirements.

In view of the possible capacity additions within the basic materials industries, the possible need for high levels of investment in energy-producing and energy-consuming industries, and stricter pollution control requirements, the total U.S. investment in plant and equipment could be considerable in coming years. Financing this increased plant and equipment investment could be a major challenge for the U.S. financial system in the coming decade.

On the other hand, despite these widely circulated predictions of increased investment needs, it is not at all clear that the expected plant and equipment spending will actually materialize. The economy is just now recovering from the severe recession of 1974-1975 and capacity utilization rates within most industries are very low by historical standards. Thus, in a broad range of domestic industries, there is certainly no current shortage of capacity. In 1975, real plant and equipment spending declined, reflecting the reduced incentives for capacity expansion. Moreover, the attitudes of many corporate managers towards the trade-off between growth and profitability may be changing subtly. The great external financial needs of the early 1970s resulted from corporate decisions to continue investing in new real assets, even though the cash returns from existing assets were severely depressed by historical standards. This was the basic cause of the large external financing needs in recent credit cycles.

With the memory of these years still fresh, many managers may choose to alter their objectives and plans with respect to expansion. Before embarking on new plant and equipment expansion plans, they may first require an enlarged cash flow and profit stream from existing assets, so that the expansions can be financed in large part through internal funds. If the internal funds cannot be generated, they may just scale back their investment in new capacity until the profits do recover. If, as current readings would suggest, corporate attitudes and decisions have changed in this way, they could have important ramifications for both future investment rates and external financial needs.

THREE ALTERNATIVE SCENARIOS FOR 1975-1985

The current economic and financial cross-currents make it difficult to estimate the 1975-1985 external financing requirements of corporations with any confidence or certainty. On the one hand, the investment needs apparently required to satisfy both private and public goals seem large. On the other hand, current capacity utilization figures suggest a much less immediate need. Additionally, there is a growing skepticism about private industry's willingness or ability to undertake this investment without a resurgence in internal cash flow. The two key related uncertainties are:

- To what extent will corporations undertake massive new plant and equipment spending?
- To what extent can whatever investment is undertaken be financed internally, with the cash available from retained earnings?

Rather than choose one particular point estimate for each of the key uncertainties, we shall specify a set of three possible scenarios which bracket the range of probable outcomes. The three alternative scenarios are described briefly below.

Scenario 1 is called the High Investment, Depressed Internal Funds Scenario. In this scenario, it is assumed that plant and equipment spending will climb to historically high levels, in order to satisfy many of the needs and requirements described above.[6] It is also assumed that the recent difficulties of corporations in realizing returns on their existing assets will continue, so that retained earnings and internal cash flows will remain depressed. This scenario presumes the trends of the last several credit cycles toward expanding corporate financial needs and contracting internally generated funds will continue. This scenario is perhaps most consistent with a future economy that is expanding rather rapidly and that is beset with continuing inflation and depressed corporate profits.

Scenario 2 is the High Investment, Moderate Internal Funds Scenario. In this scenario, it is again assumed that plant and equipment spending will climb to the same historically high levels assumed in Scenario 1, in order to satisfy many of the needs and requirements described above. But it is also assumed that corporate retained earnings and internal funds will expand, rebounding to the same average fraction of GNP they attained in the 1950s and early 1960s. Thus, a substantial fraction of corporate investment will be financed internally. This scenario is most consistent with a future economy that is expanding, perhaps rapidly, but without the intense inflationary pressure of recent years. Thus, corporations will be able to increase and maintain profit margins.

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[6] *In particular, it is assumed that corporate plant and equipment spending climbs to 8.8 percent of GNP, averaged over the next credit cycle. This is a full 1 percent of GNP higher than the experience of the most recent credit cycles. Thus, relative to the past, plant and equipment spending is assumed to expand considerably. While it is expressed in somewhat different terms, this assumed plant and equipment spending is approximately consistent with the assumptions of several other recent studies. See, for example: Bosworth, Duesenberry, and Carron, Capital Needs in the Seventies, Washington: Brookings, 1974; and New York Stock Exchange, The Need for Equity Capital, February, 1975.*

Scenario 3 is the Moderate Investment, Moderate Funds Scenario. For this scenario it is assumed that plant and equipment spending declines somewhat from recent levels to a new level similar to that of the 1950s and early 1960s. Within this moderately declining total, several categories of çapital spending will undoubtedly continue to increase, specifically energy-related investment, pollution control expenditures, and capacity additions within some of the basic materials industries. Most other capital spending will decrease, however. As in Scenario 2, it is assumed that corporate retained earnings and internal funds will rebound to the average levels they attained in the 1950s and early 1960s. Therefore, an increasing supply of funds is generated internally to finance what turns out to be only a moderate rate of investment, and external funds requirements are reduced. This scenario is most consistent with a future economy which is expanding at a slow or moderate rate with lower inflationary pressures, and in which corporate managers expand their productive capacity only after they have increased their returns from existing capacity.

As suggested in the brief scenario descriptions above, plant and equipment spending and adjusted retained earnings are the key variables for which assumptions have been made. The other sources and uses of funds have been chosen to be consistent with past levels, but are adjusted as necessary to be compatible with the assumed conditions in the scenarios. Specifically, corporate investment in residential construction, financial assets, and the differences between them are equal in all three scenarios, and consistent with earlier credit cycles. Depreciation and inventories are higher in the high investment scenarios, to reflect the effects of the bulge in plant and equipment spending on economic activity, and, later, depreciation. The detailed assumptions are shown in Exhibit F-15.

The table below summarizes the sources and uses of funds for non-financial business corporations which are likely to occur in Scenarios 1, 2, and 3. All estimates are shown as a percentage of GNP averaged over a prospective credit cycle.

COMPARISON OF THREE ALTERNATIVE SCENARIOS
WITH FIVE PREVIOUS CREDIT CYCLES
(percent of GNP)

	Plant & Equipment Spending	Adjusted Retained Earnings	Net External Funds Required
Credit Cycle 1 1954:3 to 1958:1	6.9	2.5	2.4
Credit Cycle 2 1958:2 to 1960:4	6.5	2.2	2.1
Credit Cycle 3 1960:1 to 1967:1	7.0	2.6	2.5
Credit Cycle 4 1967:2 to 1970:3	7.8	1.6	3.2
Credit Cycle 5 1970:4 to 1974:4	7.7	1.0	4.3
Scenario 1	8.8	1.3	5.0
Scenario 2	8.8	2.5	3.8
Scenario 3	7.2	2.5	2.4

As the final column in the table above and the bottom row in Exhibit F-15 indicate, there is a wide range of possible net external funds requirements across the three scenarios. In Scenario 1, the high investment, depressed retained earnings scenario, the net external funds required increase to a new high of 5.0 percent of GNP, a figure larger than in the 1970-1974 credit cycle and substantially larger than in earlier cycles. In Scenario 2, where profits are assumed to be higher than in 1, the net external funds requirements are 3.8 percent of GNP, somewhat lower than in the most recent credit cycle, but still high by historical standards. Finally, in Scenario 3, where investment is assumed to be lower than in 2, the net external funds required drop to 2.4 percent of GNP, substantially less than in recent years, and roughly comparable to requirements in the three earlier credit cycles.

These net external funds required are a measure of the extent to which non-financial corporations will have to rely upon financial institutions and markets for funding; and, therefore, they are a measure of the pressure corporations will exert on financial markets. One interpretation of these results suggests that if the rather high investment rates anticipated by many economists and reflected in Scenarios 1 and 2 actually occur, then corporations will exert considerable pressure on the capital markets. If corporate internal sources of funds remain depressed, then this pressure will be very high in comparison with all recent experience. Moreover, even if internal sources recover, the corporate demand for funds will still be quite high, possibly surpassed only by the levels of 1970-1974. Only if high rates of investment do not occur and internal funds recover (as in Scenario 3) will the pressure of corporate net external funds requirements slip back to the levels of earlier years.

Exhibit F-17 translates the estimates of financing needs in all three scenarios from a percentage of GNP to yearly dollar estimates. These figures will be compared directly with steel industry financing requirements in Section 4.

CORPORATE EXTERNAL NEEDS IN COMPETITION WITH OTHER SECTORS OF THE ECONOMY

The external financial needs of corporations are only one of several important financial needs in the economy.

In addition, the capital projects of state and local governments are often financed through "municipal" borrowing. Furthermore, when the federal government experiences a budget deficit, it is financed through federal borrowing. Finally, the household sector borrows in the form of both home mortgages and consumer credit. These various demands must compete for the net supply of funds, most of which are provided through financial assets acquired by the household sector.

Because the household sector is the source of most of the supply drawn on by other economic sectors, the analysis in this section will focus upon the "net financial investment" of the household sector, where the net financial investment of households is defined as the net increase in financial assets (the total supply of financing) minus the net increase in household borrowing. By subtracting household borrowing, the analysis excludes amounts which some households supply to other households. Thus, the focus is on the net financing provided by households as a sector to all other economic sectors. For all practical purposes, then, the net financial demands for funds of the corporate and government sectors must be financed through the supply of funds provided by the net financial investment of households.

There are several minor problems with the closed financial system suggested above. First of all, there are a number of minor economic sectors excluded from the analysis, specifically non-corporate businesses and farms. Fortunately, these sectors are small enough that their omission should cause no real problems. Secondly, the corporate sector, state and local governments, or the federal government actually could have negative net external financial needs; that is, they could on balance retire more debt than they raise. In recent years, however, the corporate sector and state and local governments as a group have always been borrowers.

A final element excluded from the foregoing analysis is international sources of funds. When the balance of payments on current account of the U.S. is deficit, then foreigners will be supplying net financial investments to the U.S., and vice versa. In the 1970-1974 period, for example, the U.S. did experience several periods of substantial deficits, and the rest of the world did provide some financing. Recently, however, the U.S. is enjoying substantial balance of payments surpluses, so that the funds provided by the rest of the world are actually negative. In the current era of floating exchange rates, the most reasonable forecast of future balance of payments is that, on average, they will probably be zero. Thus, the most reasonable forecast of net financial investment by the rest of the world in the U.S. is that it will, on average, be zero. If so, the financial system of the U.S. can be viewed in isolation from the rest of the world. The external financial needs of the U.S. corporations and governments must be equal to the net financial investment supplied by U.S. households for this to be true.

Because corporate and governmental financial needs must be supplied by households, the final link in the analysis is to investigate the savings behavior of households. For the purposes of this analysis, the "net saving" of households is defined as the sum of their accumulation of net financial investment (financial assets minus financial liabilities) plus the net increase in residential construction (the dollar value of new houses purchased by households minus the depreciation of the existing housing stock).

Exhibit F-16 documents the savings behavior of households over the previously mentioned five credit cycles. The data suggest that the rate of households' net savings (as a percent of GNP) has fluctuated between 5.4 and 6.6 percent. Numerous other long-term studies of household savings behavior in recent decades confirm that net savings rates fluctuate approximately in this range, with no discernible long-term secular trend.[7,8] On the other hand, there has been a drastic shift in the composition of net household savings across these five credit cycles. In the credit cycles of the 1950s, the net saving of households was dominated by the increase in net residential construction. In the later credit cycles, however, new home construction became a much less important form of saving, and net financial investment became the dominant component of saving. Needless to say, most of this net financial investment was used to fund the growing net external financing requirements of business in these periods. The increased funds requirements in the corporate sector may well have "crowded out" additional housing in these years.

THE SUPPLY AND DEMAND FOR FUNDS IN THREE ALTERNATIVE SCENARIOS

Because of the relatively steady behavior of households' net saving in recent cycles, it is possible to make some initial observations about the capacity of the U.S. financial system to fund various future corporate needs. It is assumed that households in future credit cycles will save in the range of 5.5 to 6.5 percent of GNP, about the range over the last five credit cycles. These net savings must then be divided between net investment in homes and net financial investment. The latter is, in turn, divided into

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[7] *The exception to this is the unusual savings rate in times of extreme economic or political conditions; e.g., World War II and the Great Depression.*

[8] *See, for example, Friedman, M., A Theory of the Consumption Function, Princeton University Press, 1957.*

funds for corporate, state and local government, and federal government financial needs. The table below shows the magnitude of corporate external requirements, in relation to households' net saving, assuming the latter to be 6 percent of GNP.

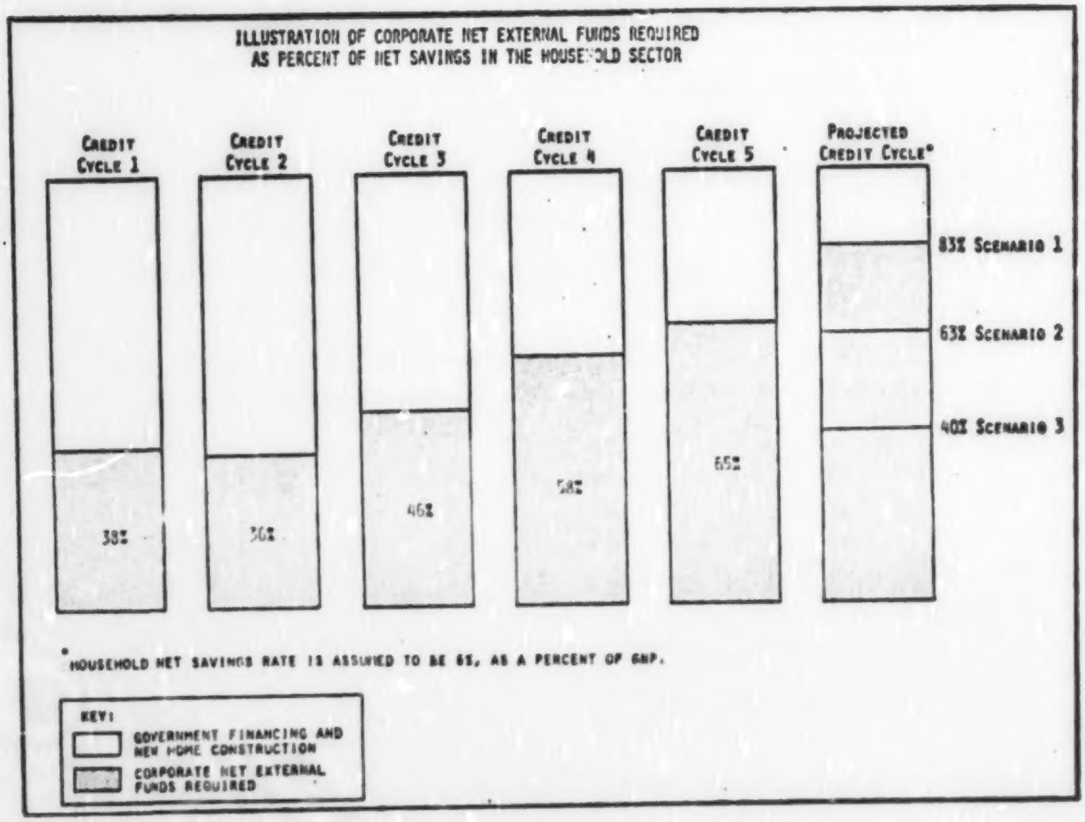
ILLUSTRATION OF CORPORATE NET EXTERNAL FUNDS REQUIRED AS PERCENT OF NET SAVINGS IN THE HOUSEHOLD SECTOR

*Household net savings rate is assumed to be 6%, as a percent of GNP.

Although the foregoing table may suggest that housing and governmental financing are a residual, this is not the case. The governmental sector is a strong competitor for funds. Therefore, a brief review of the historical and possible future levels of the other demands for funds must be analyzed. As Exhibit F-16 suggests, the net increase in residential construction has fluctuated from 1.3 to 1.9 percent of GNP in recent credit cycles, down sharply from the 1950s. While demographic and economic factors suggest that the construction of new housing may remain relatively depressed, it is difficult to imagine its falling below this range (1.3 to 1.9 percent) without seriously endangering national housing goals. From a public policy perspective, it would be most desirable to maintain enough financial capacity to fund new housing in the vicinity of at least 1.5 percent of GNP.

It is true that, in past periods of credit tightness, the response of households has, in effect, been to shift funds from housing to corporations. In the late stages of each of the recent credit cycles, households have increased substantially their purchases of corporate securities, either directly through brokers or indirectly through mutual funds and related vehicles. The process has involved a transfer of household funds to high-yielding corporate securities and from the deposit institutions that invest primarily or importantly in mortgages. This shift of funds from deposits to direct purchases, called disintermediation, has occurred in each of the recent credit crunches. The magnitude of the diversion of funds from mortgages may be smaller in the future than in the past.

In recent years, several large and growing off-budget federal agencies, the Federal National Mortgage Association (FNMA) and the Federal Home Loan Mortgage Corporation (FHLMC), have been established to supplement the flow of money to residential mortgages. These federal agencies are now very effective competitors for funds in the federal agency securities market and are likely in the future to step up their activities in periods of credit stringency so that the flow of funds to the mortgage markets is somewhat less volatile. If so, the emergence of these agencies will clearly make it more difficult for corporations to bid funds away from the mortgage market.

The external financial needs of state and local governments have accounted for a rather steady but important amount of financing in recent years. Averaged over recent credit cycles, the net external financing of state and local govenrments (that is, the total increase in external financing minus the increase in financial assets held) has fluctuated between 0.6 and 0.8 percent of GNP. Despite this stable history, predictions of future municipal financing needs are extraordinarily difficult. An abatement of the basic needs of municipalities seems unlikely. However, the historical cyclical behavior of state and local governments suggests they are sensitive to interest rate savings, curtailing their financing in times of high needs in other sectors. Thus, to the extent that future increases in the needs of other sectors over a full cycle manifest themselves in increases in interest rates, municipal borrowers may be "crowded out" in a high corporate investment economy.

The final large financial demand, that of the federal government, has fluctuated widely from year to year. In the credit cycles of the 1950s, the net external financial needs of the federal government were approximately zero, because of the balanced budget philosophy of those years. In the most recent credit cycle, however, these net external financing needs exceeded 1 percent of GNP. Again predictions of the net effect of federal taxing and expenditure decisions are perilous. It seems unreasonable, however, not to consider deficits as a strong future possibility.

With this background on possible future levels of financing needs in the housing and governmental sectors, the financial implications of the three corporate scenarios can be set in perspective. Under Scenario 1, where corporations continue to expand their rate of investment without a recovery in internal funds, the external financing needs of corporations would require virtually all of the net savings of households, leaving very little available for new housing, state and local governments, and the federal government.[9] This scenario is indeed a "capital shortage" scenario, where considerable strains would almost certainly be placed upon the financial system. Indeed, Scenario 1 is probably a workable projection only if the government sector as a whole actually supplies funds to the system. Otherwise, in order to bring the system to equilibrium, some combination of new housing, small business, state and local governments, and financially weak larger corporations would be "crowded out" in the competition for funds.

Even under Scenario 2, the financial needs of the corporate sector would appear to be quite large in relation to potentially available funds. Over 60 percent of households' net savings would be required to finance corporate needs, leaving only a modest amount for housing and governments. Presumably, if the federal government averaged zero financial needs over the future credit cycle, then Scenario 2 could be realized with a minimum of financial strain. If, however, the federal government managed its affairs so as to produce a sizeable net deficit averaged over the credit cycle, a possibility which most political observers find far more plausible, then the combined financial needs of the federal government and the corporate sector would still "crowd out" some potential borrowers.

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[9] *All of this assumes that the Federal Reserve chooses to expand the supply of money and bank credit at rates consistent with economic growth. In the short run, of course, the Federal Reserve theoretically could choose to supply enormous amounts of money and credit through the banks. The result in the long run would be enormous inflation. We are assuming implicitly an "appropriate" monetary policy in our analysis; that is, a monetary policy which is tied to real economic growth.*

Scenario 3 is the most encouraging scenario, at least from the perspective of the supply and demand for funds. In Scenario 3, the external financing needs of corporations are modest in relation to the available supply of households' net savings. Thus, substantial funds would be available for new housing, state and local governments, and the federal government.

VARIATIONS WITHIN A CREDIT CYCLE

The projections above are all stated in terms of the supply and demand for funds as a percent of GNP, averaged across a prospective credit cycle. As pointed out in the first section, however, there are substantial fluctuations in the demands for credit within a cycle. If, on average, these needs are large, then a typical credit cycle could be described as a series of subperiods, during some of which funds are not readily available. During the subperiod of peak corporate financial needs, there will be particularly great strains on the financial system. In Scenario 1, and probably even in Scenario 2, this will be a time when the corporate financial needs will exceed substantially the normal sources of supply.

CONCLUSIONS

The preceding discussion considers future financial flows of funds through a presentation of three alternative projections of corporate external needs. The three alternative scenarios present drastically different assessments of the potential availability of funds. If Scenario 1 occurs, there will almost certainly be a substantial "capital shortage," complete with the crowding out of weaker economic sectors. If Scenario 2 occurs, the external needs of corporations could probably be financed, along with moderate new housing and state and local government projects, as long as the federal government did not run at a substantial deficit. If Scenario 3 occurs, corporate external needs could be easily financed, leaving substantial funds available for other uses.

These three scenarios were constructed to bracket the range of probable outcomes. As of late 1976, the moderate investment projection of Scenario 3 seems more likely than Scenario 2 and much more likely than Scenario 1. The current level of capacity utilization and of business concerns about profitless capacity expansion tend to suggest an attention to profits and a constraint on investment for at least the next several years. Thus, there is a good chance that future corporate financial needs can be met without placing undue strains on the financial system. A more pessimistic appraisal might emphasize the chance that corporate financial needs will be very large relative to the potential supply of funds, placing substantial strains on the financial system. While the pessimistic scenarios are perhaps ones having a relatively low probability, they cannot be discounted completely. Over the entire 1975-1985 decade, however, the high investment-low profit assumptions in Scenario 1 seem inconsistent with recent corporate behavior, and thus much less probable than the assumptions of either Scenario 2 or 3.

STEEL INDUSTRY CAPITAL AVAILABILITY, 1975-1983

Early portions of this Appendix have reviewed the financing history of U.S. non-financial corporations during the 1960 to 1975 period and related this history to the experience of the domestic steel industry. Following that discussion, projections of total corporate financing requirements through 1983 were presented as a building block for this section. This section presents an analysis of the steel industry's external financing needs in light of the requirements of the total non-financial corporate sector. In so doing, this section enlarges on the disucssion of steel industry external financing needs presented in Section 7 of the report.

There are several assumptions that provide the foundation for the projections of steel industry external financing. First, TBS has assumed that there will be no change in the long-term average ratio of equity to long-term debt. Although new issues of debt and equity will not be separated in the discussion below, this assumption is important as it concerns the relative amounts of tax deductible vs. non-tax deductible charges against the industry's revenues and the amount of financial risk inherent in the industry's securities. Thus, large changes in the capitalization ratio could be expected to cause some change in the total amount of external financing required and perhaps a large change in the cost of this financing. Smaller fluctuations in the capitalization ratio would not have significant effects.

In addition to maintaining the long-term capitalization ratio, TBS has assumed that the industry will earn a real return on equity of 3.5 percent, the average of steel corporations from 1962 to 1972. The sensitivity of external financing needs to this assumption was discussed in Section 7 and Appendix E. The proportion of net income paid out to stockholders is also assumed to remain at its historical average level of 55.6 percent.

Internal cash generation in an industry as capital intensive as the steel industry depends heavily upon the accounting procedures employed. As previously mentioned, this analysis follows industry practice in assuming straight-line depreciation with a lifetime of 18 years for production equipment and 14.5 years for pollution control equipment. Taxes within Ptm(Steel) have been segmented into federal income taxes, state income taxes, property taxes and excise taxes. The average rates for these taxes, which are discussed in Volume II, Section 4, remain constant over the time of this analysis.

STEEL INDUSTRY CAPITAL NEEDS, 1975-1985

Exhibit F-18 displays the external financing needs of the steel industry from 1975 to 1983 and expresses these needs as percents of the total for all non-financial corporations. The table below summarizes this exhibit.

STEEL INDUSTRY EXTERNAL CAPITAL NEEDS
1975-1983
(billions of 1975 dollars)

	Scenario 1	Scenario 2	Scenario 3
Total Steel Industry	17.54	17.54	17.54
Total Non-Financial Corporations	821.00	622.00	384.00
Steel Percent of Total (%)	2.14	2.82	4.57

The total external financing needs of the steel industry are expected to equal $17.5 billion over the 1975 to 1983 period, with the major portion of this requirement, $13.0 billion, necessary for baseline capacity expansion and modernization. The financing requirements for water and air pollution regulations will be approximately equal at $2.5 billion and $2.1 billion, respectively. These total financing needs will require an average annual issue of external financing of approximately $2.0 billion. This amount is substantially larger than the industry has issued in any of the past 15 years.

The external financing requirements for all domestic, non-financial corporations have been expressed as a function of the three scenarios described in the third part of this appendix. Scenario 1 represents a high investment, depressed internal sources economy wherein capital expenditures climb to relatively high levels while corporate retained earnings remain depressed. Scenario 2 assumes the same high level of capital expenditures while allowing corporate internal cash flows to recover to moderate levels. Scenario 3 assumes more moderate levels of capital expenditures and also allows internal cash flow in the corporate sector to recover. The dollar estimates of required external financing for each scenario have been developed as described previously. They range from $821.0 billion for Scenario 1 to $384,0 billion for Scenario 3.

The baseline external financing requirements for the steel industry, as shown in Exhibit F-18, will require from 1.6 to 3.4 percent of the total requirements for all domestic, non-financial corporations. Pollution control financing will add another .6 to 1.2 percent to these requirements, yielding a total external financing requirement for the steel industry of 2.1 to 4.6 percent of the total for non-financial corporations.

The table below compares the steel industry's share of total external financing for the past and projections for the future.

STEEL INDUSTRY EXTERNAL FINANCING AS A PERCENT OF TOTAL FOR NON-FINANCIAL CORPORATIONS

(percent)

1960-1964		2.11
1965-1969		0.80
1970-1974		0.75
1975-1983	Scenario 1	2.14
	Scenario 2	2.82
	Scenario 3	4.57

For all scenarios, the steel industry's projected share is from 2.7 to 6.1 times their average percentage in the 1965 to 1969 and 1970 to 1974 periods. Only in the period from 1960 to 1964 did the industry's proportion of the total come close to their projected proportion in any of the three scenarios. Thus the future external financing needs of the steel industry represent both a nominal increase over past requirements and an increase in the industry's share of the total external financing required by domestic, non-financial corporations. Although shipments of steel might be different under the three scenarios, they would vary in proportion to the availability of capital so that the ranges analyzed here are greater than would probably occur.

Exhibit F-19 displays the total interest charges for long-term debt projected for the industry in the 1975 to 1983 period and compares these to the total earnings before interest and taxes in each year. From these figures the coverage ratio for each year is calculated. These coverage ratios exhibit a trend downward from 1975 to 1981 with a slight increase in 1982 and 1983. They represent in general a lower ratio of earnings before interest and taxes to interest charges than occurred in any previous years with the exception of the 1970 to 1972 period. However, the interest coverage ratios for all years appear large enough that access to capital in the form of long-term debt should not become appreciably limited. Individual companies with relatively low bond ratings, more debt-intensive capital structures, and/or relatively less diversity may have more difficulty in obtaining significant new external financing than the industry as a whole.

CONCLUSIONS

The overall availability of capital in the next decade has been analyzed in this appendix by means of three scenarios. Under the conditions of Scenarios 2 and 3, the amount of capital available is not a problem due to the resurgence of corporate internally-generated funds. In Scenario 1, overall capital availability would be more troublesome due to high levels of projected capital expenditures and continued low levels of corporate internal funds. As of late 1976, the moderate investment of Scenario 3 seems more likely than Scenario 2 and much more likely than Scenario 1.

The ability of major non-financial corporations to finance their operations appears to be feasible under all three of the projected scenarios--the unanswered question is the difficulty of so doing in terms of the cost of capital in the form of interest rate or stock price. The capital availability question is most relevant to the marginal, interest-sensitive borrower. Normally, these borrowers would include state and local governments, small business firms, and individuals requiring home mortgages and/or consumer credit. The steel industry is large and strong enough so that is should be able to raise capital, but unless the industry's common stock price improves, which in turn probably requires an improvement in the industry's return on equity, the cost of equity financing may be very high. However, the recent history of the industry makes this presumption somewhat tenuous.

As described earlier in this appendix, the steel industry has not needed to enter the capital markets for significant financing in the last 15 years. During this same period, the industry has suffered from relatively poor levels of return on equity and resulting low values of the industry's equity in the eyes of investors. Furthermore, the capital structure of the industry has grown slightly more debt-intensive and interest coverage ratios have been falling slowly.

The period from 1975 to 1983 is projected to bring with it substantially larger capital expenditures and external financing needs than seen in the previous 15 years. This will require that the industry attract from three to six times the proportion of total external financing than it has in the past decade. The ability of the industry to do this will depend on several factors.

First, the industry must be able to pass-through the increased operating costs and capital charges associated with expansion and environmental regulations so as to be able to earn an adequate return on its common equity. Over the last decade, the industry's rate of return on common equity, when adjusted for inflation, has averaged one-half of the average for all manufacturing firms.

Second, the steel industry must improve the valuation of its equity in the eyes of investors. During the last decade, the industry has been burdened with a steadily declining assessment by financial analysts and investors in general. The static operating environment and low profitability help to explain the industry's performance in the stock market. As discussed earlier, for the past five years the ratio of market value to book value for the six major integrated steel firms has approximated 0.5. This means that investors have valued the industry's securities at one-half of the amount which these securities would yield if the industry could liquidate its assets at book values. If the steel industry were required to issue common stock under these market conditions, the value of existing stockholders would be diluted; thus discouraging further investment. Unless stock prices increase to a level approximating book value, the need for continued financing in the long run would discourage investors in the short run.

If the steel industry is unable to issue common stock at prices near book value, they will have the option of either cutting back on expansion plans or modifying the historic debt-to-equity ratio of 30 to 40 percent. As discussed in Sections 6 and 7 of the report, the steel industry would be healthier financially if steel demand exceeded capacity rather than vice versa. Because the optimistic growth requirements, coupled with the capital needs for pollution control equipment, would create extremely large external financing requirements, it is more likely that the steel industry would take a conservative growth approach and add capacity at a somewhat slower rate. The combination of slower expansion, continued modernization of existing capacity, and compliance with environmental regulations would be managable, both in the short and long run.

If the industry desires to expand at a more rapid rate and is unable to issue common stock prices near book value, it could conceivably finance expansion and pollution control entirely through issues of long-term debt. If this were done, the debt-to-equity ratio would equal 100 percent by 1983. While this financing mix might be acceptable to investors, the cause for the shift and its magnitude would most likely have an adverse impact upon the current bond ratings of firms within the steel industry.

In summary, it would appear that if the industry is able to achieve levels of profitability consistent with the average for the manufacturing sector of the economy and if it is able to manage its capacity expansion in a reasonable fashion, raising the required external financing over the next decade will be possible. It will not be an easy task.

Exhibit F-1

TOTAL USES OF FUNDS AND FINANCING NEED BY YEAR
Domestic Non-Financial Business Corporations
1960-1974
(billions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Real Assets	$38.7	$36.3	$43.6	$45.2	$51.6	$62.3	$76.5	$71.4	$75.0	$83.0	$84.0	$87.2	$102.5	$121.5	$125.9
Plant and Equipment	34.6	32.9	36.6	38.2	43.7	52.3	61.1	61.9	66.5	74.0	75.1	77.1	87.1	103.3	111.7
Residential Construction	1.1	1.9	2.3	2.6	2.1	2.0	1.1	2.3	2.1	2.9	3.3	4.9	5.7	5.3	3.2
Inventory	3.0	1.5	4.7	4.3	5.9	7.9	14.4	7.3	6.4	6.7	5.7	5.1	9.7	12.9	10.9
Net Financial Assets	(0.6)	7.9	7.1	6.8	8.2	8.0	1.9	9.2	11.5	6.6	4.4	19.2	16.7	18.8	23.6
Liquid Assets	(4.1)	3.2	3.7	4.8	1.2	2.6	(3.7)	4.8	8.0	2.3	(0.4)	10.6	4.0	6.9	13.2
Net Trade and Consumer Credit	1.4	2.6	1.5	(0.1)	2.6	2.1	2.0	1.2	1.4	2.1	1.6	2.5	7.9	6.5	4.0
New Miscellaneous Assets	2.1	2.1	1.9	2.1	2.8	3.3	3.6	3.2	2.1	2.2	3.2	6.1	4.8	5.4	6.4
Discrepancy	6.0	5.0	4.5	5.6	7.4	8.9	8.3	5.9	9.6	6.0	6.7	10.2	14.8	13.8	13.6
Total Financing Need	$44.1	$49.2	$55.2	$57.6	$67.2	$79.2	$86.7	$86.5	$96.1	$96.3	$95.3	$116.6	$133.9	$154.1	$163.1

Source: Flow of Funds Statistics, Board of Governors of the Federal Reserve System, Third Quarter 1975

Exhibit F-2

USES OF FUNDS AND FINANCING NEEDS IN FIVE CREDIT CYCLES

Domestic Non-Financial Business Corporations

(all data are flows as a percent of GNP averaged over recent credit cycles)

(third quarter 1954 to fourth quarter 1974)

	Credit Cycle 1 1954:3 to 1958:1	Credit Cycle 2 1958:2 to 1960:4	Credit Cycle 3 1961:1 to 1967:1	Credit Cycle 4 1967:2 to 1970:3	Credit Cycle 5 1970:4 to 1974:4
Total Real Assets	7.6	7.2	8.3	8.8	8.9
Plant and Equipment	6.9	6.5	7.0	7.8	7.7
Residential Construction	0.2	0.3	0.3	0.3	0.4
Inventory	0.5	0.4	1.0	0.7	0.8
Net Financial Assets	0.9	1.1	1.1	1.0	1.5
Discrepancy	0.9	1.0	1.1	0.7	1.1
Total Financing Need	9.5	9.3	10.5	10.6	11.4

Source: Flows of Funds Statistics, Board of Governors of the Federal Reserve System, Third Quarter 1975

Exhibit F-3

SOURCES OF FUNDS BY YEAR

Domestic Non-Financial Business Corporations

1960-1974

(billions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total Financing Need	$44.1	$49.2	$55.2	$57.6	$67.2	$79.2	$86.7	$86.5	$96.1	$96.3	$95.3	$116.8	$133.9	$154.1	$163.1
Funds Internally Generated	34.4	35.6	41.8	43.9	50.5	56.6	61.2	61.5	61.7	60.7	59.4	68.0	78.7	84.6	81.5
Adjusted Retained Profits	10.1	10.1	12.7	13.1	17.7	21.2	23.0	20.0	16.6	10.9	5.8	10.3	15.7	17.1	9.0
Capital Consumption Allowances (Depreciation)	24.2	25.4	29.2	30.8	32.8	35.2	38.2	41.5	45.1	49.8	53.6	57.7	63.0	67.5	72.5
External Funds Raised	9.7	13.7	13.4	13.7	15.0	22.6	25.6	24.9	34.4	35.6	35.8	48.8	55.2	69.5	81.5
Bank Loans and Other Short-Term Debt	2.1	2.8	3.9	5.5	6.1	13.4	10.1	3.5	16.1	15.5	5.2	7.0	15.9	34.9	45.3
Long-Term Funds	7.5	10.8	9.5	8.2	8.9	9.2	15.5	21.4	18.4	20.0	30.4	41.5	39.2	34.5	36.3
Equity	1.5	2.2	0.4	(0.6)	1.3	(0.1)	1.1	2.2	(0.2)	3.4	5.7	11.4	10.9	7.4	4.1
Long-Term Debt[1]	6.0	8.6	9.1	8.8	7.6	9.3	14.4	19.2	18.6	16.6	24.7	30.1	28.3	27.1	32.2
Mortgage Bonds	2.5	4.0	4.5	4.9	3.6	3.9	4.2	4.5	5.7	4.6	5.2	11.3	15.6	16.1	10.9
Debentures[1]	3.5	4.6	4.6	3.9	4.0	5.4	10.2	14.7	12.9	12.0	19.5	18.8	12.2	9.2	21.3

[1] *Includes tax exempt financing, 1971 to 1973*

Source: Flow of Funds Statistics, Board of Governors of the Federal Reserve System, Third Quarter 1975

Notes to Exhibit F-3

Explanation of terms:

Total Financing Need: The cash used to finance business activity, including both the cash used to fund investment in physical assets such as plant and equipment and the value of the increase in physical inventories, and the cash necessary to fund financial requirements such as net trade credit and short-term financial assets.

Funds Internally Generated: The funds provided by ongoing operations, including both the cash generated by earnings and by depreciation.

External Funds Raised: The funds which must be raised externally in the capital markets, either through intermediaries such as commercial banks or directly through the issuance of securities.

Adjusted Retained Profits: The cash realized from reported earnings which is available for investment in the firm (computed by taking profits before taxes, adding repatriated foreign profits, and subtracting corporate profit taxes, dividends, and the inventory valuation adjustment which measures the component of profits due solely to increased inventory values.)

Capital Consumption Allowances: The non-cash expense items including principally depreciation and depletion allowances which have been subtracted at an earlier stage to yield profits before tax, but which do not represent a cash outflow, are merely an accounting recognition of past cash expenditures.

Equity: The net funds raised from equity sources in the period, including the cash received from gross new issues of equity minus equity retirements for various purposes.

Long-Term Debt: The net increase in outstanding external long-term debt in the period, including debentures, bonds, and in recent years some small amounts of tax-exempt pollution control bonds.

Long-Term Funds: The sum of equity and long-term debt.

Exhibit F-4

SOURCES OF FUNDS IN FIVE CREDIT CYCLES

Domestic Non-Financial Business Corporations
(all data are flows as a percent of GNP averaged over recent credit cycles)
(third quarter 1954 to fourth quarter 1974)

	Credit Cycle 1 1954:3 to 1958:1	Credit Cycle 2 1958:2 to 1960:4	Credit Cycle 3 1961:1 to 1967:1	Credit Cycle 4 1967:2 to 1970:3	Credit Cycle 5 1970:4 to 1974:4
Total Sources of Funds	9.5	9.3	10.5	10.6	11.4
Funds Internally Generated	6.9	6.9	7.7	6.9	6.4
Adjusted Retained Earnings	2.5	2.2	2.6	1.6	1.0
Capital Consumption	4.4	4.8	5.1	5.3	5.3
External Funds Raised	2.5	2.4	2.7	3.7	5.1
Bank Loans and Other Short-Term Debt	0.6	0.6	1.0	1.2	1.9
Long-Term Funds	1.9	1.8	1.7	2.5	3.2
Equity	0.4	0.4	0.1	0.3	0.7
Long-Term Debt	1.5	1.4	1.6	2.2	2.5
Increase in Liquid Assets	0.1	0.3	0.3	0.5	0.7
Net External Funds Required	2.4	2.1	2.5	3.2	4.3

Source: . Flow of Funds Statistics, Board of Governors of the Federal Reserve System, Third Quarter 1975

Exhibit F-5

THE CYCLES OF EXTERNAL FUNDS--SHORT-TERM DEBT, LONG-TERM DEBT, NET EQUITY ISSUES
NON-FINANCIAL BUSINESS CORPORATIONS
THIRD QUARTER 1954 TO SECOND QUARTER 1974
(SEASONALLY ADJUSTED, SMOOTHED, ANNUAL RATES AS A PERCENT OF GNP)

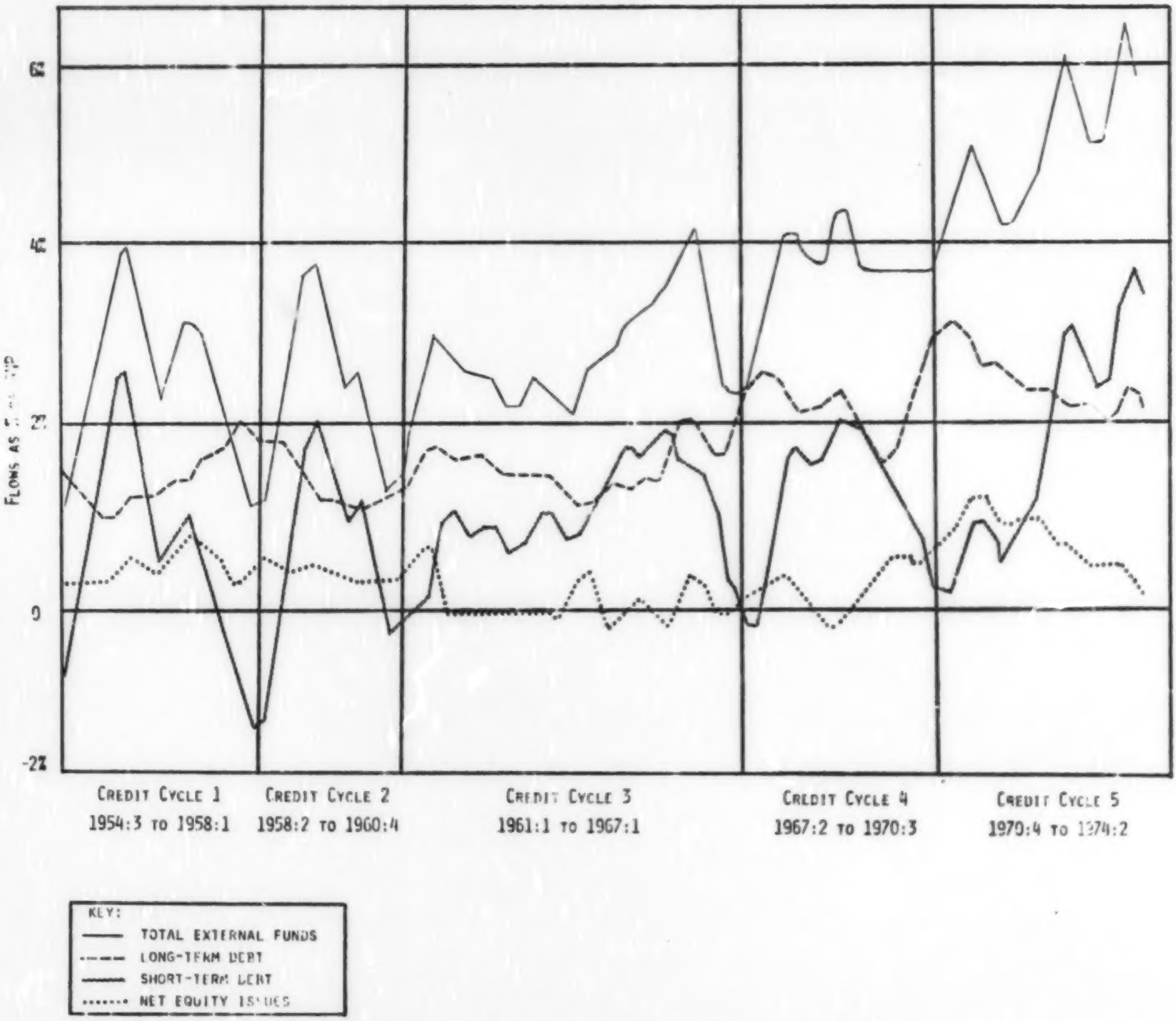


Exhibit F-6

LEVELS OF LIQUID ASSETS AND DEBT OUTSTANDING, AS PERCENT OF GNP
NON-FINANCIAL BUSINESS CORPORATIONS

THIRD QUARTER 1954 TO FOURTH QUARTER 1974

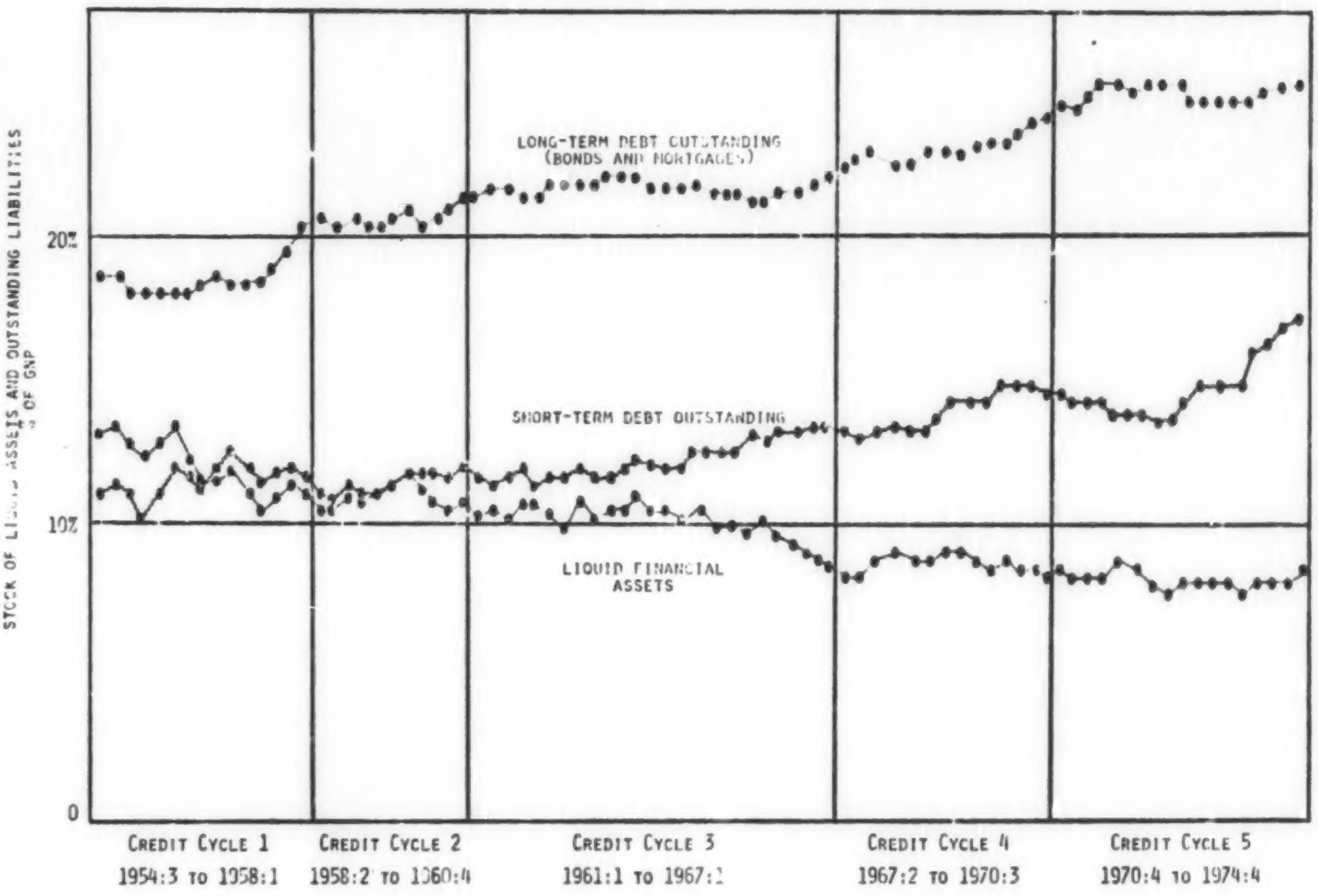


Exhibit F-7

NET INCREASE IN FINANCIAL LIABILITIES BY YEAR

Major Economic Sectors
1960-1974
(billions of dollars)

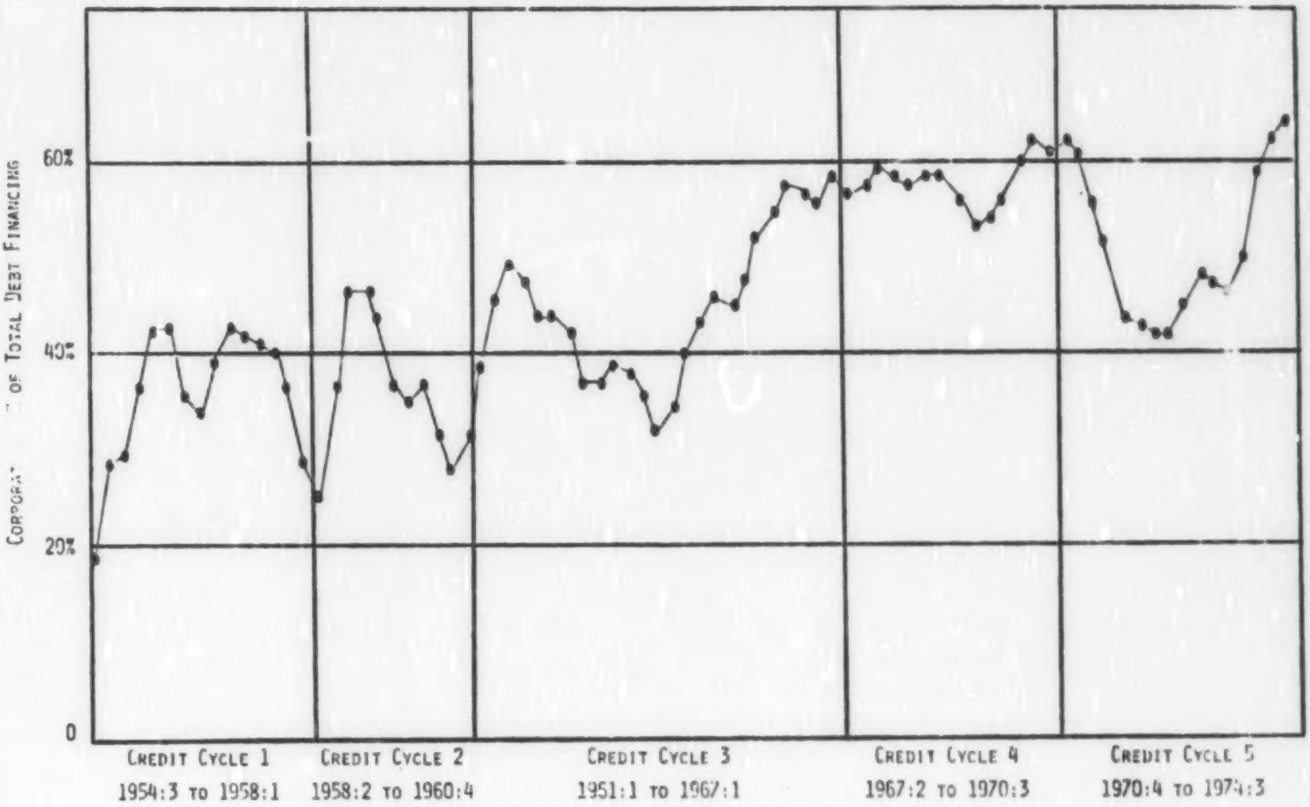
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Household Borrowing															
Residential Home Mortgages	$10.8	$10.9	$12.7	$14.8	$16.0	$15.2	$12.7	$10.4	$14.6	$16.1	$12.5	$24.2	$38.4	$44.2	$32.6
Consumer Credit	4.6	0.8	5.8	7.9	8.5	9.6	6.3	4.5	10.0	10.4	6.0	11.2	19.1	22.9	9.6
Government Borrowing															
U.S. Treasury Securities[1]	(2.2)	5.7	6.2	4.1	5.4	1.3	2.3	8.9	10.3	(1.3)	12.9	26.0	13.9	7.7	12.0
State/Local Government Securities	5.3	5.1	5.4	5.7	6.0	7.3	5.6	7.8	9.5	9.9	11.3	17.5	13.8	11.9	15.7
Corporate Business (non-financial)															
External Funds Raised	9.7	13.7	13.4	13.7	15.0	22.6	25.6	24.9	34.4	35.6	35.8	48.8	55.2	69.5	81.5

[1] *Net borrowing of the Treasury. A substantial fraction of this debt is purchased by U.S. Trust Funds and the Federal Reserve, and thus these numbers overstate the "net borrowing of the Federal Government sector." On the other hand, many Federal agencies have borrowed heavily in recent years. Because most of this Federal agency borrowing is "recycled" to the mortgage market, it is excluded here.*

Source: Flow of Funds Statistics, Board of Governors of the Federal Reserve System, Third Quarter 1975

Exhibit F-8

CORPORATE BUSINESS DEBT FINANCING
AS A PERCENT OF TOTAL PRIVATE SECTOR DEBT FINANCING[1]
THIRD QUARTER 1954 TO THIRD QUARTER 1974



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[1] SPECIFICALLY, THE INCREASE IN CORPORATE SHORT-TERMS AND LONG-TERM DEBT AS A PERCENT OF THE INCREASE IN CORPORATE SHORT-TERM AND LONG-TERM DEBT PLUS HOME MORTGAGE, FINANCING PLUS CONSUMER CERDIT.

Exhibit F-9

TOTAL STEEL INDUSTRY USES OF FUNDS
1960-1974
(billions of current dollars)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Capital Expenditures	1.52	0.96	0.91	1.04	1.59	1.82	1.95	2.15	2.31	2.05	1.74	1.43	1.17	1.40	2.10
Changes in Working Capital	(0.15)	0.37	0.05	0.26	(0.23)	0.17	(0.15)	(0.14)	(0.36)	(0.34)	0.35	(0.06)	0.36	0.68	0.96
Miscellaneous and Other	(0.20)	0.04	(0.06)	(0.07)	0.31	0	0.07	(0.01)	0.22	(0.31)	(0.30)	0.08	0.16	(0.18)	0
Total Steel Industry[1]	1.17	1.37	0.90	1.23	1.67	1.99	1.87	2.00	2.17	1.40	1.79	1.45	1.69	1.90	3.06
Total for Domestic Non-Financial Corporations	44.1	49.2	55.2	57.6	67.2	79.2	86.7	86.5	96.1	96.3	95.3	116.8	133.9	154.1	163.1
Steel Industry as % of Total	2.65	2.78	1.63	2.14	2.49	2.51	2.16	2.31	2.26	1.45	1.88	1.24	1.26	1.23	1.88

[1] Total uses may not equal total sources on Exhibit F-10 due to rounding.

Source: American Iron and Steel Institute, Annual Statistical Reports

Exhibit F-10

TOTAL STEEL INDUSTRY SOURCES OF FUNDS

1960-1974

(billions of current dollars)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Internal Sources															
Retained Earnings	0.25	0.13	0.05	0.34	0.53	0.60	0.59	0.35	0.54	0.39	0.04	0.17	0.37	0.83	1.81
Depreciation	0.70	0.74	0.93	1.00	1.06	1.10	1.17	1.20	0.97	1.04	1.04	1.08	1.17	1.26	1.34
Changes in Reserves	0.01	0.01	0.03	0.04	0.02	0.02	0.03	0.24	0.35	0.13	0.08	0.05	0.05	0.07	0.24
Total Steel Industry[1]	0.96	0.88	1.01	1.38	1.61	1.72	1.79	1.79	1.86	1.56	1.16	1.30	1.59	2.16	3.39
Total for Domestic Non-Financial Corporations	34.4	35.6	41.8	43.9	50.5	56.6	61.2	61.5	61.7	60.7	59.4	68.0	78.7	84.6	81.5
Steel Industry as % of Total	2.79	2.47	2.42	3.14	3.19	3.04	2.92	2.91	3.01	2.57	1.95	1.91	2.02	2.55	4.16
External Sources															
Issues of Long-Term Debt	0.19	0.48	(0.12)	0.02	(0.08)	0.25	0.66	0.42	0.40	0.01	0.53	0.01	0.09	(0.27)	(0.31)
Issues of Common Equity	0.03	0	0.02	(0.16)	0.18	0.03	(0.55)	(0.23)	(0.09)	(0.17)	0.09	0.14	0.02	0.01	(0.01)
Total Steel Industry[1]	0.21	0.48	(0.10)	(0.14)	1.00	0.28	0.08	0.19	0.31	(0.16)	0.62	0.15	0.11	(0.26)	(0.32)
Total for Domestic Non-Financial Corporations	9.7	13.7	13.4	13.7	15.0	22.6	25.6	24.9	34.4	35.6	35.8	48.8	55.2	69.5	81.5
Steel Industry as % of Total	2.16	3.50	-	-	0.67	1.24	0.31	0.76	0.90	-	1.73	0.31	0.20	-	-

[1] Total sources may not equal total uses on Exhibit F-9 due to rounding.

Source: American Iron and Steel Institute, Annual Statistical Reports

Exhibit F-11

STEEL INDUSTRY PAYMENTS TO STOCKHOLDERS
1960-1974
(billions of current dollars)

	Net Income	Dividends Paid	Retained Earnings	Dividend Payout Ratio[1] (%)
1960	0.81	0.56	0.25	69.1
1961	0.69	0.56	0.13	81.2
1962	0.57	0.51	0.06	89.5
1963	0.78	0.44	0.34	56.4
1964	0.99	0.46	0.53	46.5
1965	1.07	0.47	0.60	43.9
1966	1.07	0.48	0.59	44.9
1967	0.83	0.48	0.35	57.8
1968	0.99	0.45	0.54	45.5
1969	0.88	0.49	0.39	55.7
1970	0.53	0.49	0.04	92.5
1971	0.56	0.39	0.17	69.6
1972	0.77	0.40	0.37	51.9
1973	1.27	0.44	0.83	34.6
1974	2.48	0.67	1.81	27.0

[1] Defined as dividends paid ÷ net income

Source: American Iron and Steel Institute, Annual Statistical Reports

Exhibit F-12

STEEL INDUSTRY CAPITAL STRUCTURE
1960-1974
(percent)

	Reserves and Deferred Credits	Long-Term Debt	Equity
1960	4.23	18.28	77.47
1961	4.11	20.90	74.97
1962	4.33	20.17	75.48
1963	4.53	18.77	76.68
1964	4.26	19.27	76.45
1965	4.11	19.74	76.12
1966	4.10	22.90	72.94
1967	5.31	24.30	70.31
1968	6.86	24.87	68.20
1969	7.42	24.42	68.01
1970	7.55	26.12	65.98
1971	7.66	25.75	66.48
1972	7.68	25.51	66.72
1973	7.75	23.45	68.56
1974	8.21	20.31	71.21

Source: American Iron and Steel Institute, Annual Statistical Reports

Exhibit F-13

FINANCIAL PARAMETERS FOR THE TOP SIX COMPANIES IN THE STEEL INDUSTRY

1960-1974

	Average Price/ Earnings Ratio	Average Market Price/ Book Value
1960	19.12	1.98
1961	22.69	1.96
1962	18.02	1.41
1963	13.31	1.43
1964	12.00	1.51
1965	10.79	1.36
1966	9.48	1.08
1967	11.72	0.98
1968	9.17	0.83
1969	9.84	1.07
1970	12.56	0.57
1971	12.08[a]	0.53
1972	10.29	0.58
1973	6.06	0.53
1974	3.35[a]	0.50[b]

[a] 5-company average

[b] 4-company average

Source: Moody's Industrials Manual

Exhibit F-14

STEEL INDUSTRY INTEREST COVERAGE RATIOS
1960-1974
(billions of current dollars)

	Total Interest Charges	Earnings Before Interest and Taxes	EBIT/Interest
1960	.1014	1.9770	19.50
1961	.1225	1.6762	13.68
1962	.1323	1.4425	10.90
1963	.1276	1.8385	14.41
1964	.1291	2.1305	16.50
1965	.1372	2.2714	16.56
1966	.1776	2.2899	12.89
1967	.1850	1.7284	9.34
1968	.2245	2.0867	9.29
1969	.2457	1.9283	7.85
1970	.2885	1.3789	4.78
1971	.3321	1.5501	4.67
1972	.3458	1.9735	5.71
1973	.3574	2.9488	8.25
1974	.3537	5.1576	14.58

Source: American Iron and Steel Institute, Annual Statistical Reports

Exhibit F-15

PROJECTIONS OF FUTURE SOURCES AND USES OF FUNDS

Domestic Non-Financial Business Corporations

(all projections are shown as a percent of GNP averaged over a prospective credit cycle)

	Scenario 1	Scenario 2	Scenario 3
Total Financing Need			
Plant & Equipment	8.8	8.8	7.2
Residential Construction	0.3	0.3	0.3
Inventories	0.8	0.8	0.7
Net Financial Assets	1.2	1.2	1.2
Discrepancy	1.0	1.0	1.0
Total Sources of Funds			
Funds Generated Internally	6.6	7.8	7.5
Adjusted Retained Earnings	1.3	2.5	2.5
Depreciation	5.3	5.3	5.0
External Funds Raised	5.5	4.3	2.9
Increase in Liquid Financial Assets	0.5	0.5	0.5
Net External Funds Required	5.0	3.8	2.4

Source: TBS projections

Exhibit F-16

SAVINGS BEHAVIOR OF U.S. HOUSEHOLDS

(all data as percent of GNP averaged over a credit cycle)

	Credit Cycle 1 1954:3 to 1958:1	Credit Cycle 2 1958:2 to 1960:4	Credit Cycle 3 1961:1 to 1967:1	Credit Cycle 4 1967:2 to 1970:3	Credit Cycle 5 1970:4 to 1974:4
Net Savings	6.3	5.8	5.4	5.5	6.6
Net Increase In Residential Construction[1]	3.8	3.1	1.9	1.3	1.8
Net Financial Investment[2]	2.5	2.7	3.5	4.2	4.8

[1] Net Increase in Residential Construction is the dollar value of newly constructed 1- to 4-family homes purchased by households, minus the depreciation imputed to the existing stock of such homes owned by households. It does not include changes in the market value of existing homes.

[2] Net Financial Investment is the dollar value of the net purchase of financial assets minus the dollar value of the net increases in financial liabilities for all households.

Source: Federal Reserve Flow of Funds data, second quarter 1975

Exhibit F-17

PROJECTIONS OF TOTAL CAPITAL NEEDS BY YEAR

Domestic Non-Financial Business Corporations
1975-1985
(billions of 1975 dollars)[1]

Assumptions for:	Scenario 1	Scenario 2	Scenario 3
Real GNP Growth	3.5%	3.5%	3.0%
Level of Plant and Equipment Investment	High	High	Low
Level of Retained Earnings	Low	High	High
Total Corporate Capital Raised, as % of GNP	5.0%	3.8%	2.4%

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Cumulative 1975-1985
Scenario 1												
GNP (3.5% growth)	1,582	1,638	1,695	1,754	1,816	1,878	1,945	2,013	2,084	2,157	2,233	20,795
Total Corporate Capital Raised (5% GNP)	79	82	85	88	91	94	97	101	104	108	112	1,041
Scenario 2												
GNP (3.5% growth)	1,582	1,638	1,695	1,754	1,816	1,878	1,945	2,013	2,084	2,157	2,233	20,795
Total Corporate Capital Raised (3.8% GNP)	60	62	64	67	69	71	74	76	79	82	85	789
Scenario 3												
GNP (3.0% growth)	1,574	1,622	1,670	1,720	1,772	1,824	1,880	1,936	1,994	2,054	2,116	20,162
Total Corporate Capital Raised (2.4% GNP)	38	39	40	41	43	44	45	46	48	49	51	484

[1] 1975 dollars assumed to include 9.5 percent inflation over 1974 dollars.

Note: Results assume 14 percent return on equity.

Exhibit F-18

PROJECTIONS OF STEEL INDUSTRY EXTERNAL FINANCING AS A PERCENT OF THE TOTAL FOR DOMESTIC, NON-FINANCIAL CORPORATIONS

1975-1983

(billions of 1975 dollars)

	Scenario 1	Scenario 2	Scenario 3
Baseline Conditions	12.99	12.99	12.99
Water Pollution Control	2.49	2.49	2.49
Air Pollution Control	2.06	2.06	2.06
Total Steel Industry	17.54	17.54	17.54
Total for Domestic, Non-Financing Corporations	821.00	622.00	384.00
Steel Industry Percent of Total (%)			
Baseline Conditions	1.58	2.09	3.38
All Pollution Control	.55	.73	1.18
Total Steel Industry	2.14	2.82	4.57

Source: PTm(Steel)

Exhibit F-19

STEEL INDUSTRY PROJECTED INTEREST COVERAGE
1975-1983
(billions of current dollars)

	TOTAL Interest Charges	Earnings Before Interest and Taxes	EBIT/Interest
1975	.48	3.59	7.48
1976	.51	3.32	6.51
1977	.61	3.52	5.77
1978	.70	3.78	5.40
1979	.77	4.01	5.21
1980	.83	4.21	5.07
1981	.89	4.49	5.04
1982	.95	4.84	5.09
1983	1.02	5.22	5.12

Source: PTm(Steel)

APPENDIX G

ENERGY AND EMPLOYMENT IMPACTS OF ENVIRONMENTAL REGULATIONS

APPENDIX G

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APPENDIX G

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G-2 1975-1983

Employment By Process

G-3 1974
G-4 1977
G-5 1980
G-6 1983

ENERGY AND EMPLOYMENT IMPACTS OF ENVIRONMENTAL REGULATIONS

Section 8 of this report presents the energy, employment, community and balance of trade impacts of environmental regulations on the steel industry. The most significant of these impacts concern changes in the industry's consumption of energy and level of employment. This appendix will present additional detail concerning the energy and employment impacts.

ENERGY IMPACTS

Exhibits G-1 and G-2 present energy consumption by process unit. These exhibits supplement Exhibits 30 and 31 of the report. Exhibit G-1 shows the total consumption over the period from 1975 to 1983 and Exhibit G-2 displays the consumption in a single year, 1983, when full compliance with pollution control regulations is achieved.

The process-related energy consumption figures shown in Exhibits G-1 and G-2 have been calculated from engineering estimates of fuel and power use per process. These estimates were provided by Arthur D. Little for the production process and by EPA technical contractors for air and water pollution control equipment. Because ADL did not provide energy use parameters for the cold finished bars and vacuum degassing processes, the consumption figures shown for these relate to pollution control equipment only.

The calculated electric power consumption figures for each process are converted to a Btu consumption figure by use of a weighted average heat rate. This heat rate, equal provided by Arthur D. Little and EPA technical contractors. It was assumed by ADL in this calculation that labor charges comprised 80 percent of overhead and selling, general and administrative (SGA) costs. The labor component of each category was then divided by the average annual wage of a production worker in each year to obtain production job equivalents.

The data provided by Arthur D. Little did not include direct labor or overhead and SGA parameters for the vacuum degassing and cold finishing processes. Thus, the employment figures for these categories represent air and water pollution control equipment only.

Exhibit G-1

ENERGY CONSUMPTION BY PROCESS
1975-1985

(trillion Btu)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	48.15	-	-	48.15
Coal Yard	17,896.97	-	-	17,896.97
Scrap Yard	32.49	-	-	32.49
Sinter Strand	558.43	.30	37.34	596.07
Coke Oven	(3,717.35)	7.51	-	(3,709.84)
Iron Making				
Blast Furnace	(3,626.76)	10.80	33.21	(3,582.75)
Steel Making				
Open Hearth Furnace	868.18	.08	12.16	880.42
Basic Oxygen Furnace	595.66	1.80	-	597.46
Electric Furnace	1,468.07	.78	29.13	1,497.98
Vacuum Degassing[2]	6.62	27.64	-	34.26
Casting and Forming Continuous Casting				
Billets and Blooms	81.52	4.50	-	86.02
Slabs	120.68	7.13	-	127.81
Conventional Casting				
Ingot Casting	-	-	-	-
Breaking - Blooms	496.11	5.87	-	501.98
Breaking - Billets	620.74	4.52	-	625.26
Breaking - Slabs	1,195.18	17.32	-	1,212.50
Finishing Mills				
Heavy Structurals	276.85	4.84	-	281.50
Hot Rolled Bar and Rod	790.32	47.51	-	837.83
Wire Product	13.16	8.39	-	21.55
Cold Finished Bar[2]	.89	4.51	-	5.40
Seamless Pipe and Tube	260.92	9.19	-	270.11
Hot Rolled Strip	2,392.20	81.60	-	2,473.80
Pickling and Oiling	71.48	33.58	-	105.06
Welded Pipe and Tube	374.19	16.34	-	390.53
Cold Rolled Strip	1,046.70	8.40	-	1,055.10
Hot Coating - Galvanizing and Terne	141.61	1.74	-	143.35
Cold Coating - Tin and Chrome	235.54	3.14	-	238.68
Plate	703.57	22.37	-	725.94
Total	22,952.12	329.87	111.83	23,393.82

[1] Includes pollution control equipment placed into service prior to 1975

[2] Air and water pollution control only

Source: PTm(Steel)

Exhibit G-2

ENERGY CONSUMPTION BY PROCESS
1983
(trillion Btu)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	5.95	-	-	5.95
Coal Yard	2,210.85	-	-	2,210.85
Scrap Yard	4.01	-	-	4.01
Sinter Strand	68.99	.09	5.43	74.51
Coke Oven	(459.28)	2.18	-	(457.10)
Iron Making				
Blast Furnace	(448.29)	2.09	6.82	(439.38)
Steel Making				
Open Hearth Furnace	76.22	.01	2.43	78.66
Basic Oxygen Furnace	75.25	.41	-	75.66
Electric Furnace	190.95	.16	5.06	196.17
Vacuum Degassing[2]	.74	6.44	-	7.18
Casting and Forming Continuous Casting				
Billets and Blooms	14.31	1.15	-	15.46
Slabs	21.12	1.73	-	22.85
Conventional Casting				
Ingot Casting	-	-	-	-
Breaking - Blooms	52.72	.95	-	53.67
Breaking - Billets	70.23	.99	-	71.22
Breaking - Slabs	136.27	2.97	-	139.24
Finishing Mills				
Heavy Structurals	34.24	1.14	-	35.38
Hot Rolled Bar and Rod	99.14	9.63	-	108.77
Wire Product	1.50	1.15	-	2.65
Cold Finished Bar[2]	.11	.73	-	.84
Seamless Pipe and Tube	31.55	1.54	-	33.09
Hot Rolled Strip	298.79	16.52	-	315.31
Pickling and Oiling	8.87	5.42	-	14.29
Welded Pipe and Tube	45.46	2.36	-	47.82
Cold Rolled Strip	129.10	1.33	-	130.43
Hot Coating - Galvanizing and Terne	18.29	.34	-	18.63
Cold Coating - Tin and Chrome	28.38	.54	-	28.92
Plate	88.52	3.59	-	92.11
Total	2,803.96	63.48	19.74	2,887.18

[1] Includes pollution control equipment placed into service prior to 1975

[2] Air and water pollution control only

Source: PTm(Steel)

Exhibit G-3

EMPLOYMENT BY PROCESS
1974
(jobs)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	7,374	-	-	7,374
Coal Yard	3,435	-	-	3,435
Scrap Yard	15,089	-	-	15,089
Sinter Strand	7,852	-	-	7,852
Coke Oven	21,798	-	-	21,798
Iron Making				
Blast Furnace	22,335	-	-	22,335
Steel Making				
Open Hearth Furnace	43,153	-	-	43,153
Basic Oxygen Furnace	43,483	-	-	43,483
Electric Furnace	33,861	-	-	33,861
Vacuum Degassing[2]	109	-	-	109
Casting and Forming Continuous Casting				
Billets and Blooms	1,447	-	-	1,447
Slabs	13,800	-	-	13,800
Conventional Casting				
Ingot Casting	7,612	-	-	7,612
Breaking - Blooms	10,455	-	-	10,455
Breaking - Billets	16,821	-	-	16,821
Breaking - Slabs	23,571	-	-	23,571
Finishing Mills				
Heavy Structurals	2,885	-	-	2,885
Hot Rolled Bar and Rod	25,163	-	-	25,163
Wire Product	9,973	-	-	9,973
Cold Finished Bar[2]	3	-	-	3
Seamless Pipe and Tube	3,393	-	-	3,393
Hot Rolled Strip	42,499	-	-	42,499
Pickling and Oiling	16,259	-	-	16,259
Welded Pipe and Tube	11,892	-	-	11,892
Cold Rolled Strip	49,535	-	-	49,535
Hot Coating - Galvanizing and Terne	4,197	-	-	4,197
Cold Coating - Tin and Chrome	6,467	-	-	6,467
Plate	22,367	-	-	22,367
Total	466,832	-	-	466,832

[1] Includes pollution control equipment placed into service prior to 1975

[2] Air and water pollution control only

Source: PTm(Steel)

Exhibit G-4

EMPLOYMENT BY PROCESS
1977
(jobs)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	7,141	-	-	7,141
Coal Yard	3,317	-	-	3,317
Scrap Yard	14,556	-	-	14,556
Sinter Strand	7,607	1	66	7,673
Coke Oven	21,055	14	-	21,069
Iron Making				
Blast Furnace	21,652	54	-	21,706
Steel Making				
Open Hearth Furnace	33,556	2	-	33,558
Basic Oxygen Furnace	44,795	8	8	44,811
Electric Furnace	33,374	5	61	33,440
Vacuum Degassing[2]	109	59	-	168
Casting and Forming Continuous Casting				
Billets and Blooms	2,116	22	-	2,137
Slabs	14,517	23	-	14,540
Conventional Casting				
Ingot Casting	7,816	-	-	7,186
Breaking - Blooms	9,617	22	-	9,689
Breaking - Billets	16,033	13	-	16,045
Breaking - Slabs	22,345	54	-	22,399
Finishing Mills				
Heavy Structurals	2,793	13	-	2,806
Hot Rolled Bar and Rod	24,254	102	-	24,355
Wire Product	9,611	13	-	9,624
Cold Finished Bar[2]	3	11	-	14
Seamless Pipe and Tube	4,119	15	-	4,134
Hot Rolled Strip	41,169	179	-	41,348
Pickling and Oiling	15,654	195	-	15,850
Welded Pipe and Tube	9,031	35	-	9,066
Cold Rolled Strip	48,579	12	-	48,592
Hot Coating - Galvanizing and Terne	4,401	11	-	4,412
Cold Coating - Tin and Chrome	5,680	17	-	5,697
Plate	20,368	60	-	20,429
Total	444,637	939	135	445,711

[1] Includes pollution control equipment placed into service prior to 1975

[2] Air and water pollution control only

Source: PTm(Steel)

Exhibit G-5

EMPLOYMENT BY PROCESS
1980

(jobs)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	7,155	-	-	7,155
Coal Yard	3,304	-	-	3,304
Scrap Yard	14,547	-	-	14,547
Sinter Strand	7,623	2	141	7,766
Coke Oven	20,972	50	-	21,021
Iron Making				
Blast Furnace	21,598	130	1,101	22,829
Steel Making				
Open Hearth Furnace	26,092	3	407	26,502
Basic Oxygen Furnace	47,351	17	186	47,554
Electric Furnace	34,648	8	645	35,301
Vacuum Degassing[2]	109	87	-	196
Casting and Forming Continuous Casting				
Billets and Blooms	2,754	53	-	2,807
Slabs	20,513	59	-	20,572
Conventional Casting				
Ingot Casting	6,794	-	-	6,794
Breaking - Blooms	8,927	45	-	8,972
Breaking - Billets	15,375	31	-	15,407
Breaking - Slabs	21,183	114	-	21,297
Finishing Mills				
Heavy Structurals	2,805	34	-	2,839
Hot Rolled Bar and Rod	24,550	261	-	24,810
Wire Product	9,214	21	-	9,234
Cold Finished Bar[2]	3	23	-	25
Seamless Pipe and Tube	4,046	29	-	4,075
Hot Rolled Strip	41,572	455	-	42,027
Pickling and Oiling	15,745	417	-	16,163
Welded Pipe and Tube	8,910	51	-	8,961
Cold Rolled Strip	48,697	26	-	48,723
Hot Coating - Galvanizing and Terne	4,621	24	-	4,646
Cold Coating - Tin and Chrome	5,590	27	-	5,617
Plate	20,626	127	-	20,753
Total	445,324	2,095	2,480	449,899

[1] Includes pollution control equipment placed into service prior to 1975

[2] Air and water pollution control only

Source: PTm(Steel)

Exhibit G-6

EMPLOYMENT BY PROCESS
1983
(jobs)

	Baseline Conditions[1]	Pollution Control Equipment		Total
		Water	Air	
Raw Materials Preparation				
Ore Yard	7,137	-	-	7,137
Coal Yard	3,279	-	-	3,279
Scrap Yard	14,429	-	-	14,429
Sinter Strand	7,606	4	146	7,756
Coke Oven	20,815	126	-	20,942
Iron Making				
Blast Furnace	21,430	184	1,143	22,757
Steel Making				
Open Hearth Furnace	20,139	4	407	20,550
Basic Oxygen Furnace	49,171	30	200	49,401
Electric Furnace	35,246	13	680	35,938
Vacuum Degassing[2]	109	133	-	241
Casting and Forming **Continuous Casting**				
Billets and Blooms	3,771	106	-	3,877
Slabs	27,314	103	-	27,418
Conventional Casting				
Ingot Casting	6,229	-	-	6,229
Breaking - Blooms	7,734	50	-	7,784
Breaking - Billets	14,085	52	-	14,137
Breaking - Slabs	19,730	135	-	19,865
Finishing Mills				
Heavy Structurals	2,808	63	-	2,870
Hot Rolled Bar and Rod	24,750	450	-	25,200
Wire Product	8,832	21	-	8,853
Cold Finished Bar[2]	4	25	-	29
Seamless Pipe and Tube	3,970	37	-	4,007
Hot Rolled Strip	41,606	774	-	42,379
Pickling and Oiling	15,785	455	-	16,240
Welded Pipe and Tube	8,778	54	-	8,832
Cold Rolled Strip	48,671	28	-	48,699
Hot Coating - Galvanizing and Terne	4,807	33	-	4,840
Cold Coating - Tin and Chrome	5,494	34	-	5,527
Plate	20,802	134	-	20,936
Total	444,530	3,047	2,576	450,153

[1] Includes pollution control equipment placed into service prior to 1975

[2] Air and water pollution control only

Source: PTm(Steel)